eridob
European researchers in didactics of biology

UNIVERSITY OF LJUBLJANA | PEF Faculty of Education

15th Conference of European Researchers in Didactics of Biology

Ljubljana - Slovenia, August 24th-28th 2026.

Book of abstracts and conference schedule

Ljubljana, 2026

ERIDOB 2026

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Layout and techical editing: Žan Rode
Published by: University of Ljubljana Press
For the publisher: Gregor Majdič, the Rector
Issued by: University of Ljubljana, Faculty of Education
For the issuer: Karmen Pižorn, the Dean
First digital edition.
Publication is available online in PDF format at: https://eridob26.si/files/2026/08/BOOK-OF-ABSTRACTS-ERIDOB-2026-7.pdf and https://ebooks.uni-lj.si/
DOI: 10.26529/9789612978754
Publication is free of charge.
Ljubljana, 2026

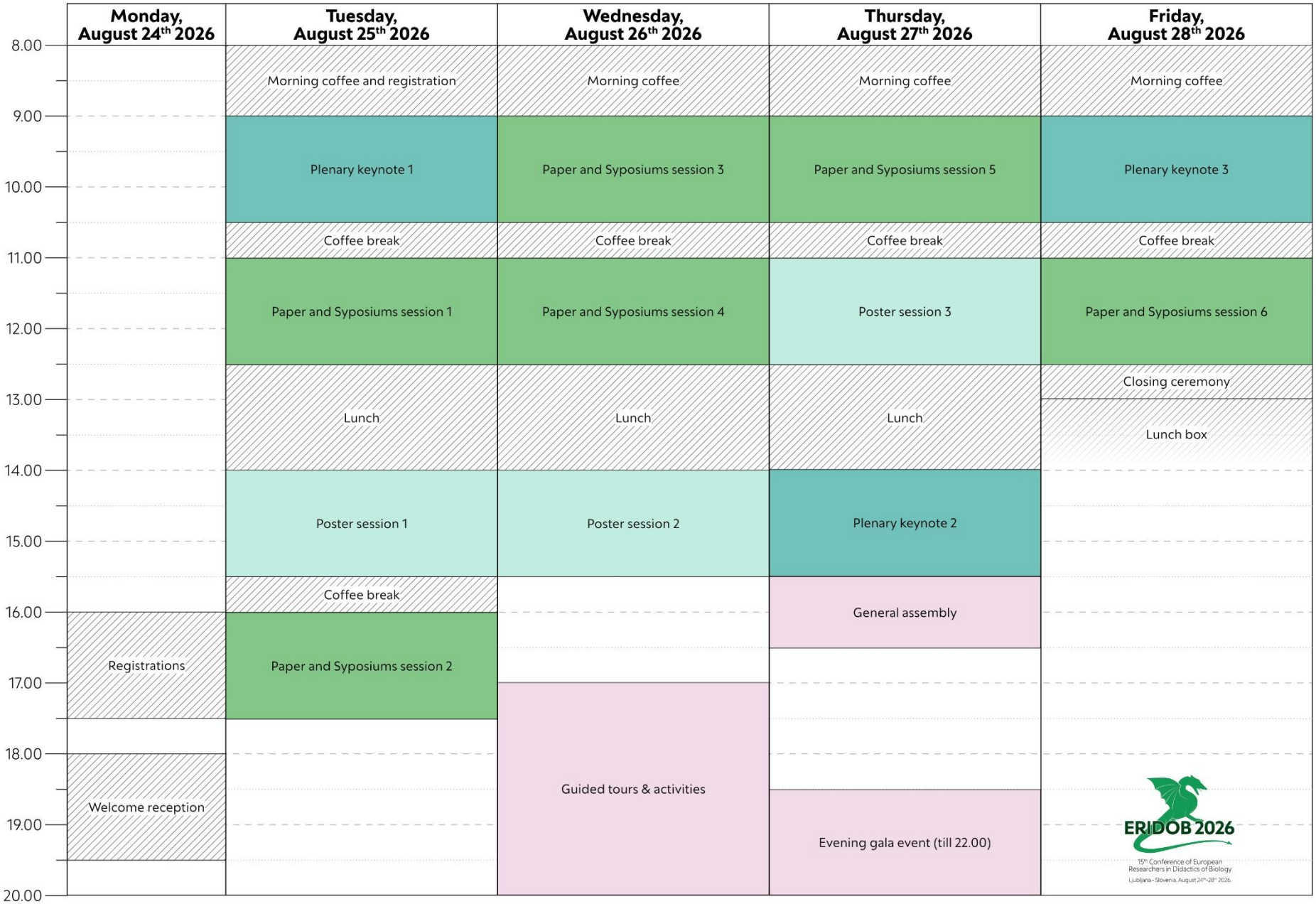
Kataložni zapis o publikaciji (CIP) pripravili v Narodni in univerzitetni knjižnici COBISS.SI-ID 288243203
ISBN 978-961-297-875-4 (PDF)

Dear colleagues,

We are pleased to present the Book of Abstracts and Conference Schedule for the 15th Conference of the European Researchers in Didactics of Biology (ERIDOB), held at the Faculty of Education University of Ljubljana, Slovenia. The ERIDOB brings together researchers in biology education from across Europe and beyond to share, discuss, and advance our research and our understanding of biology teaching and learning. We are meeting at a particularly important time. Science is facing strong expectations to contribute to addressing the major challenges of our era, while, at the same time, scientific knowledge and scientific findings are increasingly questioned and, sometimes, openly discredited. In such circumstances, biology education has an especially important role to play. It is not only about understanding biological concepts; it is also about developing the ability to evaluate evidence, think critically, understand uncertainty, and make informed decisions about the future of our society and our planet. This is why the conference theme, "Biology education paving the way for our common future," is both timely and inspiring.

This document provides abstracts of all submissions, sorted alphabetically by the first authors' surname, an overview of the planned sessions, keynote lectures, paper presentations, poster sessions and symposia taking place during the conference. It is intended to help participants navigate the programme, plan their attendance, and make the most of opportunities for academic exchange, networking, and collaboration within the biology education research community. Please note that the schedule may be subject to minor changes, and participants are encouraged to consult the latest version for updated information. By clicking on the table of contents you can search through the schedule. At the end the whole list of submissions is provided, with scheduled times for easier navigation.

ERIDOB 2026 organizing committee


Monday, August 24th 2026
Tuesday, August 25th 2026
Wednesday, August 26th 2026
Thursday, August 27th 2026
Friday, August 28th 2026
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
16.00
17.00
18.00
19.00
20.00
Morning coffee and registration
Morning coffee
Morning coffee
Morning coffee
Plenary keynote 1
Paper and Syposiums session 3
Paper and Syposiums session 5
Plenary keynote 3
Coffee break
Coffee break
Coffee break
Coffee break
Paper and Syposiums session 1
Paper and Syposiums session 4
Poster session 3
Paper and Syposiums session 6
Closing ceremony
Lunch
Lunch
Lunch
Lunch box
Poster session 1
Poster session 2
Plenary keynote 2
Coffee break
General assembly
Registrations
Paper and Syposiums session 2
Guided tours & activities
Welcome reception
Evening gala event (till 22.00)
ERIDOB 2026
15th Conference of European Researchers in Didactics of Biology
Ljubljana - Slovenia, August 24th-28th 2026.

KEYNOTE SPEAKERS

DAY 1 – TUESDAY, 25.8.

Michael A. Ranney

Prof. Michael Ranney (University of California, Berkeley) researches explanations and understandings about challenging domains—as well as how to improve them (e.g., on global climate change; see HowGlobalWarmingWorks.org). He studies reasoning involving supportive and contradictory relations—while generating curricula, methods, and software designed to improve rational thinking—despite people's largely-fragmentary knowledge (and in diverse realms such as biology, physics, abortion, and immigration). In addition to cognition about evolution and climate change, Ranney has published in fields such as animal learning, environmental psychology, journalism education, numeracy, algebra recognition, social psychology, intelligent tutoring systems, artificial intelligence, philosophy, and (general) science education. Ranney's main training was in diverse parts of Psychology but recruited broader fields: his first publications were in Applied Physics and Materials Science, and he also majored in Microbiology. Before coming to Berkeley, he was a Postdoctoral Fellow in Cognitive Science at Princeton University, and he is a 2025 Fulbright Scholar.

DAY 3 – THURSDAY, 27.8.

Miha Krofel

Miha Krofel is an associate professor and senior researcher at the Biotechnical Faculty, University of Ljubljana, where he leads the Research group for wildlife ecology and management. He also works as visiting scientist at the IZW-Leibniz Institute for Zoo and Wildlife Research (Germany), external collaborator of CIBIO (Portugal) and guest lecturer at University of Oxford (U.K.) and University of Porto (Portugal). He is also serving as a member of IUCN SSC Cat Specialist Group, Canid Specialist Group and Large Carnivore Initiative for Europe. His main research focus is on carnivore ecology, management and conservation in Europe, Africa and Asia. Main study species include Eurasian lynx, brown bear, grey wolf, golden jackal, African big cats, snow leopard, European wildcat, various lizards, and several species of mammalian and avian scavengers. He was involved in genetic rescue and reintroduction of Eurasian lynx in the Dinaric Mountains and Alps, as well as several projects dealing with human-carnivore conflicts in Eurasia and Africa. Currently he is leading the ExtremePredator research project on the ecological role of large carnivores in extreme environments in Europe and Africa. He has published over 150 peer-reviewed scientific publications and regularly engages in science communication and public engagement.

DAY 4 – FRIDAY, 28.8.

Dawn Sanders

Dawn Sanders has studied both fine art and ecology. She was a botanic garden teacher before completing her doctoral study in botanic gardens as environments for learning (Sussex University, Geography department, UK). In her research work as an associate professor at the University of Gothenburg, Sweden, she focuses on interdisciplinary approaches to Life as Plant and the materiality of gardens as learning environments. Research grants include the projects: Beyond Plant Blindness: Seeing the importance of plants for a sustainable world and Biodiversity Awareness: The conceptualising of a new educational approach both funded by The Swedish Research Council. Dawn serves on the board of Gothenburg Botanical Gardens and is a Thomas Reviews editor for the journal Plants, People, Planet. She currently leads the Swedish partner contribution to the ERASMUS Teacher Academy on Nature-Based Solutions. She works across the art/science interface and is interested in how such ways of working might afford new attentional frames in teaching and learning contexts, and notions of "plantness".

KEYNOTE SPEAKERS **3**

DAY 1 – TUESDAY, 25.8. 3
Michael A. Ranney *3*
DAY 3 – THURSDAY, 27.8. 3
Miha Krofel *3*
DAY 4 – FRIDAY, 28.8. 3
Dawn Sanders *3*

DAY 1 – TUESDAY, 25.8. ..... **5**

PAPER AND SYMPOSIUM SESSION 1 | 11.00 – 12.30 5
POSTER SESSION 1 | 14.00 – 15.30 6
PAPER AND SYMPOSIUM SESSION 2 | 16.00 – 17.30 7

DAY 2 – WEDNESDAY, 26.8. ..... **9**

PAPER AND SYMPOSIUM SESSION 3 | 9.00 – 10.30 9
PAPER AND SYMPOSIUM SESSION 4 | 11.00 – 12.30 10
POSTER SESSION 2 | 14.00 – 15.30 11

DAY 3 – THURSDAY, 27.8. ..... **13**

PAPER AND SYMPOSIUM SESSION 5 | 9.00 – 10.30 13
POSTER SESSION 3 | 11.00 – 12.30 14

DAY 4 – FRIDAY, 28.8. ..... **17**

PAPER AND SYMPOSIUM SESSION 6| 11.00 – 12.30 17

SUBMISSION LIST **19**

TABLE OF CONTENTS: BOOK OF ABSTRACTS **30**

DAY 1 – TUESDAY, 25.8.

PAPER AND SYMPOSIUM SESSION 1 | 11.00 – 12.30

Room 1	Room 2	Room 3	Room 4	Room 5
249 **MAIN: EVOLUTION EDUCATION IN THE EARLY YEARS** Patrícia Pessoa, Deborah Kelemen, Isabell Adler, Lucía Vázquez-Ben and Penelope Papadopoulou Conceptual change Symposia	**25** **REVOLUTIONIZING QUALITATIVE RESEARCH: AI-ASSISTED ANALYSIS OF STUDENT CONCEPTIONS ON MICROPLASTICS** Justus Braune, Cathérine Conradty, Franz Xaver Bogner and Jürgen Paul Conceptual change Oral	**175** **MAIN: ACTION-ORIENTED SUSTAINABILITY TEACHING: STAKEHOLDER PERSPECTIVES ON OPPORTUNITIES AND CHALLENGES** Peter Lampert, Carole Chappuis, Teresa Berglund and Niklas Gericke Discussant: Jelle Boeve-de Pauw Sustainability Education (including Environmental and Health Education) Symposia	**43** **The Experiment Design Toolbox: A Novel Task Format for Assessing Competencies in Planning Experiments** Thomas Gabor, Katharina Düsing and Ute Harms Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	**7** **Holistic Education through Hackathon: Enhancing 21st-Century Skills among Fifth Graders - A Case Study** Adiv Gal and Dana Sachyani Sustainability Education (including Environmental and Health Education) Oral
60 **TEACHING AND LEARNING EVOLUTION IN EARLY CHILDHOOD EDUCATION: A MAPPING LITERATURE REVIEW** Penelope Papadopoulou, Alexandros Amprazis and Despina Tsopoglou-Gina Conceptual change Symposia	**48** **Why Don't They Get It? Identifying and Explaining Slow Spots in Explanation Progress** Francois Lombard, Sudriès Marie, Larpin Camille and Weiss Laura Conceptual change Oral	**125** **Action-Oriented Teaching for Biodiversity: Exploring Dynamics of Change** Carole Chappuis Sustainability Education (including Environmental and Health Education) Symposia	**16** **EXPLORATORY STUDY ON SYSTEM-RELATED KNOWLEDGE OF PRE-SERVICE BIOLOGY TEACHERS** Alexander Bergmann and Cornelia Averdunk Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	**8** **Cultivating Climate Activist Teachers: Insights from a Course on Environmental Education and Action- A Case Study** Dana Sachyani and Adiv Gal Sustainability Education (including Environmental and Health Education) Oral
248 **"ONE GOES EXTINCT, ONE EVOLVES": HOW 3RD GRADERS REASON ABOUT PAST AND FUTURE EVOLUTIONARY SCENARIOS (Symposium: Evolution Education in the Early Years)** Lucía Vázquez-Ben, Anxela Bugallo, Patrícia Pessoa, Neil Gostling, Nausica Kapsala, Deborah Kelemen, Ross Nehm, Giulia Realdon, Alexandra Moorman and Xana Sá-Pinto Conceptual change Symposia	**54** **Exploring Primary Pupils' Understanding of the Immune System Using Drawing Tasks and Semi-Structured Interviews** Eliza Rybska and Wiktoria Michalak Conceptual change Oral	**199** **Building action competence through action-oriented sustainability teaching in biology teacher education** Teresa Berglund and Peter Lampert Sustainability Education (including Environmental and Health Education) Symposia	**17** **Developing capabilities for critical examination of biology-related issues in the media. A design-based study in upper secondary school** Carl-Johan Rundgren, Maria Andrée, Cecilia Dudas, Kristin Persson and Josefin Reimark Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	**11** **EVALUATING THE IMPACT OF E3D ECO-LABELING ON PRIMARY SCHOOL STUDENTS' ACTION COMPETENCE FOR SUSTAINABILITY: A PILOT STUDY** Frederic Leterme, Jérémy Castéra, Magali Coupaud, Corinne Jégou, Carine Boyer, Nathalie Topalian, Solenne Albertini and Pierre-Olivier Thebault Sustainability Education (including Environmental and Health Education) Oral
223 **FOSTERING EVOLUTIONARY LITERACY AND PRO-BIODIVERSITY ATTITUDES IN ELEMENTARY STUDENTS THROUGH SOCIOSCIENTIFIC ISSUES (Symposium: Evolution Education in Early Years)** Patrícia Pessoa, J. Bernardino Lopes, Alexandre Pinto and Xana Sá-Pinto Conceptual change Symposia	**61** **TRANSFORMING CLIMATE REPRESENTATIONS: EXPERIENTIAL TOOLS IN AGRICULTURAL EDUCATION** Asloum Nina, Murillo Audrey, Del Corso Jean-Pierre and Gallai Nicola Conceptual change Oral	**176** **COLLABORATING WITH EXTERNAL STAKEHOLDERS: OPPORTUNITIES AND CHALLENGES FOR BIODIVERSITY ACTION** Peter Lampert, Teresa Berglund and Niklas Gericke Sustainability Education (including Environmental and Health Education) Symposia	**26** **Designing Inquiry-based Teaching to Enhance Students' Scientific Creativity: A Case Study with a Chinese Biology Teacher** Shiyu Xu, Michael Reiss and Wilton Lodge Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	**24** **TEACHERS AS AGENTS OF CHANGE: MOTIVATION AND AGENCY FOR TEACHING CLIMATE CHANGE** Cigdem Han Tosunoglu, Justus Schöller and Annette Upmeier Zu Belzen Sustainability Education (including Environmental and Health Education) Oral
66 **Big Ideas in elementary school: A new curriculum for learning about evolution by natural selection in third grade**	**92** **IDENTIFYING PRECONCEPTIONS IN DEVELOPMENTAL ASPECTS OF EVOLUTION** Isabel Jiménez-Bargalló and Jordi Martí-Feixas		**50** **Mechanistic Reasoning as a Lens on Children's Plant Awareness** Yael Shtechman and Michal Haskel-Ittah	**33** **Promoting Systems Thinking: The Effects of Instructional Guidance in the Combined Use of Digital System Models** Nico Tuncel, Rieß Werner and Maik Beege

Room 1	Room 2	Room 3	Room 4	Room 5
(Symposium: Evolution Education in Early Years) Deborah Kelemen, Sarah Brown, Alden Burnham, Eli Elster, Léa Combette, Gillian Puttick, Sally Crissman and Sara Lacy Conceptual change Symposia	Conceptual change Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	Sustainability Education (including Environmental and Health Education) Oral
20 **Primary school teachers' use of teleology and anthropomorphism to explain evolution** Isabell K. Adler and Sebastian Tempelmann Conceptual change Symposia				

POSTER SESSION 1 | 14.00 – 15.30

Number	Authors	Title	Strand
12	Araitz Uskola	**DEVELOPING PRESERVICE TEACHERS´ SYSTEMS THINKING BY ELABORATING NETWORKS OF IDEAS**	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS
22	Bento Cavadas and Bruno Sousa	**Representations of evolution in Portuguese science textbooks**	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS
30	Milan Kubiatko	**The storks are still homosexuals or pupils and students' ideas about basic zoological concepts**	Conceptual change
37	Maja Funke, René Leubecher and Jörg Zabel	**Passed the Test? Competence Assessment in German Biology Abitur Tasks**	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS
52	Jessica León Paredes, Cristina Valares Masa, Jesús Gómez Ochoa de Alda, María Rocío Esteban Gallego and José María Marcos Merino	**DRAWINGS OF MICROORGANISMS BY PRESCHOOL STUDENTS: DESIGN OF AN ANALYSIS RUBRIC AND COMPARISON BETWEEN HUMAN AND ARTIFICIAL INTELLIGENCE EVALUATIONS**	Conceptual change
62	Katja Malovrh, Maja Tomšič, Blanka Ravnjak and Jože Bavcon	**Teaching methods used in the University Botanic Gardens Ljubljana**	Outdoor and Informal Education
88	Karen Waskewitz and Michal Haskel Ittah	**Shifting between Mechanistic and Narrative Reasoning – Towards a dynamic view of Cognitive Construals?**	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS
103	Stephen Price and Ralph Levinson	**Making Systems Visible Without Reification: A Relational Process Systems Framework**	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS
112	Pascal Schaldach, Matthias Wilde and Tim Kirchhoff	**Exploring the qualities of nature experiences across urban and rural learning environments**	Outdoor and Informal Education
117	Gregor Torkar and Špela Klofutar	**BEYOND THE CLASSROOM: BIODIVERSITY IN ACTION**	Outdoor and Informal Education
135	Jana Quinte, Catherine Boyer, Denise Orange and Christian Orange	**SEXUAL REPRODUCTION OF FLOWERING PLANTS AND SCIENTIFIC EDUCATION OF FUTURE TEACHERS – A CASE STUDY**	Conceptual change
137	Netta Dagan, Masha Tsaushu and Tali Tal	**Between Belief and Curriculum: Teaching Evolution in a Religiously Diverse Society**	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS
151	Miri Levy, Pirchi Waxman, Efrat Link, Shoshi Herman, Irit Sadeh and Michal Zion	**A Self-Regulated Learning Support Model Integrating Internal and External Pedagogical Sensors to Foster Metacognitive Awareness in Open Inquiry-Based biology Learning**	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS
162	Amelia Abrie, Nicola Grobler and Annie Antonites	**CO-MAMMALHUB: PRE-SERVICE TEACHER CONTRIBUTIONS TO DESIGNING A MUSEUM EXHIBIT**	Outdoor and Informal Education
187	Helen Semilarski and Helin Semilarski	**BEYOND THE CLASSROOM: EXPLORING TEACHERS' ROLES IN EXTRACURRICULAR STEM PROGRAMS**	Outdoor and Informal Education
193	Léna Somano, François Bonneton and Olivier Morin	**Problematizing development to foster the understanding of living dynamics: case of sex ontogenesis.**	Conceptual change
198	Raya L. Wolf, Paul W. Dierkes and Matthias W. Kleespies	**Zoos as Educational and Conservation Spaces: Perspectives from (Future) Teachers**	Outdoor and Informal Education

203	Jorge Groß and Malte Michelsen	**Rethinking Learning Progression Research: The Potential of Students' Conceptions for Understanding Non-Linear Paths of Learning**	Conceptual change
206	Lisa Virtbauer, Lena von Kotzebue, Johanna Rehrl, Sabrina Wildner and Gabriele Gadermaier	**Students' Conceptions of (Pollen) Allergies: Exploring Ideas and Knowledge Levels in Secondary Biology Education**	Conceptual change
219	Marios Sotiriadis, Katerina Michopoulou, Efstratios Valakos and Martha Georgiou	**LEARNING ABOUT SEA ANIMALS THROUGH A PLAYFUL MUSEUM EDUCATIONAL PROGRAM**	Outdoor and Informal Education
221	Anthony Benzig	**Conception and Construction of Normality and Normativity and the Role of Biology Education**	Conceptual change
224	Panagiota Kotsakiozi, Panayiotis Pafilis, Efstratios Valakos and Martha Georgiou	**ANIMALS AND ANTHROPOMORPHISM IN CHILDREN'S LITERATURE: IMPLICATIONS FOR LEARNING ABOUT NATURE**	Conceptual change
237	Franziska Messenböck, Sonja Kletzer, Ulrich Hobusch, Wolfgang Hinterdobler, Kerstin Kremer and Martin Scheuch	**IF THERE IS PLANT BLINDNESS – ARE WE SUFFERING FROM FUNGAL FORGETFULNESS?**	Outdoor and Informal Education
244	Marjanca Kos and Špela Klofutar	**FOSTERING PLANT AWARENESS IN EARLY YEARS: ACTIVITIES AND ASSESSMENT OF THEIR EFFECTIVENESS**	Outdoor and Informal Education
245	Rachel Sawle and Neil Hart-Camus	**Exploring affective engagement between London's learners and the more-than-human**	Conceptual change
250	Leonie Johann, Magdalena Kersting and Sara Wilmes	**A Case Study on How Spatial Affordances Shape First-Grade Students' Participation in Biology Inquiry Phases within Innovative Learning Environments**	Outdoor and Informal Education
254	Nienke Wieringa, Micha Ummels, Lidewij Van Katwijk and Caspar Geraedts	**LOWERING BARRIERS FOR STUDENT TEACHERS TO TEACH OUTDOORS**	Outdoor and Informal Education
255	Myriam Régent-Kloeckner, Olivier Morin, Véronique Battie, Faïza Chellougui, Virginie Deloustal-Jorrand and Nicole Goetgheluck	**STUDENTS' CONCEPTIONS OF SCIENTIFIC EVIDENCE AND PROOF IN BIOLOGY AND MATHEMATICS HIGHER EDUCATION**	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS
256	Greta Sinning Quiroga, Justin Timm and Philipp Schmiemann	**Systems Thinking in the Context of Tipping Systems – Analysing Students' Concept Maps**	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS
263	Lena Engelmann and Carolin Retzlaff-Fürst	**NATURE JOURNALING – A METHOD TO ENHANCE ARTENWISSEN IN STUDENTS**	Outdoor and Informal Education
265	Vanessa Freemann and Anna Beniermann	**CONCEPTUAL CHANGE VIDEOS AND TEXTS - A COMPARISON OF THE EFFECTIVENESS OF STUDENTS' CONCEPT FORMATION**	Conceptual change

PAPER AND SYMPOSIUM SESSION 2 | 16.00 – 17.30

Room 1	Room 2	Room 3	Room 4	Room 5
58 **MAIN: Culturally Responsive Biology Education** Justin Dillon and Wilton Lodge Socioscientific Issues Symposia	**170** **Perceptions of present and future forests among students with and without special educational needs** Lisa-Marie Broghammer, Melanie Basten, Laura Ferreira González, Anne Reh, René Schroeder, Daniela Sellmann-Risse, Hannah Weck and Silvia Fränkel Conceptual change Oral	**87** **CAUSAL PROBLEMS IN EVERYDAY LAY REASONING: CONNECTING GOALS OF USE WITH INFORMATION TYPES** Abigail London and Michal Haskel-Ittah Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	**225** **3D MODELING AND 3D PRINTING IN BIOLOGY TEACHER TRAINING - PROBLEMS AND SOLUTIONSTRATEGIES OF STUDENTS** Mahdi El Tegani and Claas Wegner Teacher Professionalization and PCK Oral	**69** **NATURE IN SWEDISH LOWER SECONDARY BIOLOGY: WESTERN HEGEMONY OR PLURIVERSALITY?** Kate D. Molina-Gallo, Daniel Olsson, Teresa Berglund and Niklas Gericke Sustainability Education (including Environmental and Health Education) Oral
53 **"It feels like I'm touching the soil!" STEAM Gardens for a transdisciplinary and transformative science education** Laura Colucci-Gray and Jonathan Hancock Socioscientific Issues Symposia	**173** **Reducing misconceptions about natural selection: an intervention in upper secondary school** Jorun Nylehn, Ragnhild Gya and Kjersti Lea Conceptual change Oral	**93** **ANALYZING BIOLOGY TEXTBOOK QUESTION DESIGN AND STUDENT LEARNING OUTCOMES IN KOSOVO CLASSROOMS** Zeqir Veselaj and Besiana Gashi Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	**240** **Promoting collaborative biology educators' professional development for embedding climate change and sustainability in the secondary (high) school science National Curriculum in England, UK** Ruth Amos Teacher Professionalization and PCK Oral	**74** **Development and validation of a nutrition questionnaire based on KAP and HBM** Petra Olschewski, Helena Aptyka, Maren Flottmann, Corinne Wacker, Sandra Vamos and Kirsten Schlüter Sustainability Education (including Environmental and Health Education) Oral

Room 1	Room 2	Room 3	Room 4	Room 5
185 **School vaccine education needs to take account of cultural issues** Michael Reiss Socioscientific Issues Symposia	**202** **EXPLORING STUDENTS' CONCEPTIONS OF WILD BEES – INSIGHTS FROM A QUALITATIVE STUDY USING CONCEPT MAPS** Theresa Schmidt, Alexander Georg Büssing and Dagmar Hilfert-Rüppell Conceptual change Oral	**96** **Simulations as epistemic tools: A machine learning-based analysis of students' uncertainty descriptions** Simon Blauza, Kerstin Kremer and Benedikt Heuckmann Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	**113** **BIOLOGY TEACHERS' CURRICULAR KNOWLEDGE. MINDING THE GAP BETWEEN OFFICIAL AND IMPLEMENTED CURRICULUM?** Leroy Großmann and Bianca Reinisch Teacher Professionalization and PCK Oral	**75** **Supporting Coping Strategies through Emotion-sensitive Climate Change Education** Wanda Sass and Jelle Boeve-de Pauw Sustainability Education (including Environmental and Health Education) Oral
275 **CULTURALLY RESPONSIVE PEDAGOGY IN CLIMATE SCIENCE EDUCATION: EMPOWERING STUDENT VOICES** Kathrin Otrel-Cass, Joey Guercio, Iris Mendel, Michael Reicho, Annika Heher, Michaela Frieß and Thomas Kosel Socioscientific Issues Symposia	**242** **Revealing Sustainability Citizenship: An AI-Enhanced Residual Method for Large-N Qualitative Concept Analysis** Cathérine Conradty and Franz X. Bogner Conceptual change Oral	**106** **A Window into Epistemic Practices of an Online Fitness Community** Gur Arie Livni Alcasid and Iris Tabak Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral		**76** **Together for Insects? Fostering Students' Agency for Insect Conservation through Collective Action** Laura Härter and Jörg Prof. Dr. Zabel Sustainability Education (including Environmental and Health Education) Oral
				82 **Exploring pre-service teachers' choices of sustainability topic: Implications for hope and action competence** Maren Skjelstad Fredagsvik, Ragnhild Lyngved Staberg, Hilde Ervik and Vibeke Gilje Sanne Sustainability Education (including Environmental and Health Education) Oral
				83 **UNDERSTANDING TEACHER TRAINEES' CRITICAL CHOICES IN APPLYING INQUIRY-BASED LEARNING ACTIVITIES IN BIOLOGY CLASSROOMS** Daniel Manzoni-de-Almeida and Patricia Marzin-Janvier Sustainability Education (including Environmental and Health Education) Oral

DAY 2 – WEDNESDAY, 26.8.

PAPER AND SYMPOSIUM SESSION 3 | 9.00 – 10.30

Room 1	Room 2	Room 3	Room 4	Room 5
78 **How is "ancestry" conceptualized in the journal PLOS Genetics?** Lucie Tournayre, Nikos Tsourakis, Nuno Ribeiro Galheto, Alicia Sanchez-Mazas, Mathias Currat, Jose Nunes and Kostas Kampourakis Conceptual change Symposia	**41** **Students' meaning-making in ecology education** Hanna Wanselin and Kristina Danielsson Writing, Speaking, Reading and Argumentation Oral	**155** **Teacher Self-Efficacy and the Integration of 3D Printing in Science Education** Zuzana Nedvědová and Lukáš Rokos Teaching Strategies, Learning Environments and Digital Media Oral	**57** **PRE-SERVICE PRIMARY SCHOOL TEACHERS PERCEPTIONS AND PREPAREDNESS TO PLAN BIOLOGY AS INQUIRY** Karin Hecke and Isabel Jiménez Bargalló Teacher Professionalization and PCK Oral	**159** **EMOTIONAL AWARENESS IN TEACHERS' ACTION COMPETENCE FOR SUSTAINABILITY AND CLIMATE CHANGE EDUCATION** Mary Kaya, Nina Christenson, Jelle Boeve-de Pauw and Niklas Gericke Sustainability Education (including Environmental and Health Education) Oral
95 **Using Machine Learning to Assess Students' Responses to Evolution Scientific Explanation Questions** Merav Siani, Asaf Salman, Moriah Ariely, Giora Alexandron and Anat Yarden Conceptual change Symposia	**70** **Tell me more about plants!** Julia Zdunek and Jörg Zabel Writing, Speaking, Reading and Argumentation Oral	**179** **Implementation and Perception of Practical Work in Lower Secondary School Biology: Teachers' Insights** Andreja Špernjak and Katja Stanič Teaching Strategies, Learning Environments and Digital Media Oral	**63** **FOSTERING AND LINKING REFLECTION AND RESEARCH COMPETENCE AMONG PRESERVICE BIOLOGY TEACHERS** Pauline Sommerer, Helena Aptyka and Jörg Großschedl Teacher Professionalization and PCK Oral	**160** **SYSTEMS THINKING IN SUSTAINABILITY EDUCATION: CHANGE OVER TIME IN THE "SPACE JUNK" SCENARIO** Zeynep Güler and Burcu Güngör Cabbar Sustainability Education (including Environmental and Health Education) Oral
139 **How do pre-service biology teachers construe "adaptation"? Eliciting personal constructs using the repertory grid method** Florian Stern, Lucie Tournayre, Marco Barroca-Paccard and Kostas Kampourakis Conceptual change Symposia	**128** **Creation of Comics as Evolutionary Arenas: Tracing Reasoning Across Modes** Johanna Aringer, Kristina Danielsson, Ammie Berglund and Lars Wallner Writing, Speaking, Reading and Argumentation Oral	**205** **Interest-based Learning Units for the immune system: Integrating students' autonomy with curriculum requirements** Noa Kedar, Moriah Ariely and Anat Yarden Teaching Strategies, Learning Environments and Digital Media Oral	**68** **Reflection, PCK, and professional vision: Insights from pre-service biology teachers' practice** Jitka Kopecká Teacher Professionalization and PCK Oral	**174** **Unpacking Links Between Climate Literacy and Sense of Place in a Place-Based Program for Bedouin Youth** Shaima Alokbe and Orit Ben-Zvi Assaraf Sustainability Education (including Environmental and Health Education) Oral
	211 **STUDENTS' ENGAGEMENT WITH ARGUMENTATION IN MENDELIAN GENETICS: TWO-DIMENSIONAL AUTOMATED ASSESSMENT** Malka van Dijk, Moriah Ariely, Asaf Salman, Giora Alexandron and Anat Yarden Writing, Speaking, Reading and Argumentation Oral	**209** **Systems thinking through perspectives as a solution to low coherence in biology education** Berber de Jong, Michiel Dam and Fred J.J.M. Janssen Teaching Strategies, Learning Environments and Digital Media Oral	**85** **Biology Teachers as Change Agents - Potentials for Transfer of Digitally-Supported Scientific Inquiry** Ronja Sowinski, Finja Grospietsch and Moritz Krell Teacher Professionalization and PCK Oral	**181** **Outdoor Learning in a Protected Area: Insights from Urban Youth** Petra Bezeljak Cerv and Andrea Möller Sustainability Education (including Environmental and Health Education) Oral
	186 **Mandate or Motivation? An Exploratory Study of Students' Arguments and Conceptual Development on Hepatitis B Vaccination** Dagmar Hilfert-Rüppell, Katrin Vorhölter, Andreas Plink and Manuela Harries Students' Values, Attitudes and Decision-Making Oral	**210** **Combining Virtual Reality and Real Dissection in Biology Lessons: Effects on Cognitive Load, Interest, Disgust, and Learning Gain** Dorian Thomsen, Dagmar Hilfert-Rüppell and Alexander Georg Büssing Teaching Strategies, Learning Environments and Digital Media Oral	**38** **The Wolf : Neither Good nor Evil. A Case Study of a Museum Exhibition as a Didactic Device to Explore Children's Relationship to Animals and the Construction of Scientific Knowledge** Cora Cohen-Azria Outdoor and Informal Education Oral	**188** **Climate Emotions in Place-Based Education: Linking Agency, Hope, Interest and Worry through Person-Situation Interaction Theory** Justus Schöller, Anna Beniermann, Matthias Ziegler and Annette Upmeier zu Belzen Sustainability Education (including Environmental and Health Education) Oral

Room 1	Room 2	Room 3	Room 4	Room 5
		226 **Analogy competence in science teacher education: validating and refining the ACT framework** Stina Eriksson, Karin Thörne and Niklas Gericke Teaching Strategies, Learning Environments and Digital Media Oral		

PAPER AND SYMPOSIUM SESSION 4 | 11.00 – 12.30

Room 1	Room 2	Room 3	Room 4	Room 5
89 **MAIN: Advancing Evolution Learning – Novel Conceptual and Methodological Approaches to Evolution Education** Ute Harms Conceptual change Symposia	**129** **DEVELOPING BIOLOGY TEACHERS' PCK THROUGH INQUIRY-BASED MICROBIOLOGY: INSIGHTS FROM A TRAINING PROGRAMME** Lara Amorim and Betina Lopes Teacher Professionalization and PCK Oral	**241** **Fostering specific types of knowledge towards more academic success in the introductory phase of biology study programs** Julia-Marie Tocco, Kai Cardinal, Heike Theyßen, Andreas Borowski and Philipp Schmiemann Teaching Strategies, Learning Environments and Digital Media Oral	**153** **Automated assessment of biological explanations in Arabic: Using reflective-prompt-engineering based prompts with GenAI** Hadeel Edrees Dabbah, Anat Yarden, Giora Alexandron and Moriah Ariely Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	**217** **Evaluating an International Summer School on Nature-based Solutions in Science Teacher Education** Maximilian Haberbosch, Kim Oun, Johanna Nagl, Lucas Weinberg and Suzanne Kapelari Sustainability Education (including Environmental and Health Education) Oral
77 **Exploring how the concept "adaptation" is defined in scientific articles using text mining** Lucie Tournayre, Nikos Tsourakis and Kostas Kampourakis Conceptual change Symposia	**145** **Integrating Mathematics into Middle-School Biology Lessons: Teachers' Pathways to Change** Dina Bartov and Anat Yarden Teacher Professionalization and PCK Oral	**268** **THE IMPACT OF CLASSROOM TYPE ON STUDENT MOTIVATION IN SCIENCE AND BIOLOGY EDUCATION** Mirela Sertić Perić and Mia Fett Teaching Strategies, Learning Environments and Digital Media Oral	**177** **An integrated framework for evaluating students' responses to open-ended questions in biology** Moriah Ariely and Anat Yarden Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	**227** **Student Teachers' Perspectives on Farm Visits – Reflections and Critical Thinking** Pia Sjöblom and Maria Svens Sustainability Education (including Environmental and Health Education) Oral
201 **Comparing Two AI-Driven Approaches To Formative Assessment In Evolution Education** Berrit Katharina Czinczel, Merav Siani, Moriah Ariely, Anat Yarden and Ute Harms Conceptual change Symposia	**166** **Cultivating Plant Mentors: A study of Pre-Service Science Teachers' appreciation/awareness of plant science education** Charlie Pettit, Rachel Davies and Mark Winterbottom Teacher Professionalization and PCK Oral	**269** **DRAW-AND-EXPLAIN TO LEARN: COLLABORATIVE PROCESSES TO LEARN ABOUT THE IMMUNE SYSTEM** Karen Rysgård and Helena Bichao Teaching Strategies, Learning Environments and Digital Media Oral	**208** **Why Teacher Professional Learning Programs Can Fail: Evidence from a Professional Learning Program on Scientific Reasoning for Biology Teachers** Richard Sannert, Verena Petermann, Janet Carlson, Jan van Driel and Moritz Krell Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	**231** **ANALYZING PUPILS CLIMATE CHANGE "FRESKS" PRODUCTIONS THROUGH A SYSTEMS THINKING APPROACH** François Dessart, Isabel Pau-Custodio, Myriam Régent-Kloeckner, Florent Figon and Catherine Bruguière Sustainability Education (including Environmental and Health Education) Oral
164 **Exploring Pre-service Biology Teachers' Assessment Competence in Evolution using a Chatbot-supported Classroom Simulation** Johannes Poser, Daniela Fiedler, Daniel Schönle, Christoph Reich and Ute Harms	**168** **The Gemeinsamer Fortbildungstag (GFT): A Transferable Model for Practice-Oriented Professional Development in Digitally Enhanced STEM Teaching** Rebekka Siedler, Stefanie Hartmann, Maren Muth and Steffen Schaal	**39** **Professional Development for Inquiry-Based Learning: What Content Matters to Pre-service and In-service Biology Teachers?** Till Schmäing, Leo Siiman, Natalie Baumgartner Hirscher, Marlene Ganz, Moritz Krell, Holger Meeh, Sergios Nicolaou, Marios	**215** **Relevance of Task Characteristics for Preservice Biology Teachers' Modelling Processes** Felicitas Haupts, Jörg Großschedl, Nina Minkley, Till Schmäing and Moritz Krell	**238** **ENHANCING SUSTAINABILITY CONSCIOUSNESS IN SIXTH GRADE: EVIDENCE FROM AN INTEGRATED ESD AND SEL PROGRAM FROM GREECE** Myrto Koutra-Iliopoulou, Apostolia Galani, Aikaterini Plakitsi and Evangelia Mavrikaki

Room 1	Room 2	Room 3	Room 4	Room 5
Conceptual change Symposia	Teacher Professionalization and PCK Oral	Papaevripidou, Yvoni Pavlou, Iris Schiffl, Martina Schuknecht, Simone Suppert, Tanja Thumann, Armin Baur and Andreas Lampis Teaching Strategies, Learning Environments and Digital Media Oral	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	Sustainability Education (including Environmental and Health Education) Oral
	171 **Promoting Artenwissen and coherence in biology teacher education – Results from the first cohort of a design-based research study** Tom Bewersdorf and Carolin Retzlaff-Fürst Teacher Professionalization and PCK Oral		**229** **Authentic Biology Education through Citizen Science: Enhancing Students' Understanding of the Nature of Science** Leah Yifrach, Haya Ben Simon and Dina Tsybulsky Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	

POSTER SESSION 2 | 14.00 – 15.30

Number	Authors	Title	Strand
14	Ana Valdmann	**Motivation, Preparation, and Learning Strategies in the Estonian Biology Olympiad: A Comparative Study Between Basic and Upper Secondary Students**	Students' Values, Attitudes and Decision-Making
18	Irene González Costa, Blanca Puig and Paloma Blanco Anaya	**From critical reasoning to critical action: A One Health Design-Based Research**	Socioscientific Issues
28	Anne Laius and Rolf Saarna	**Assessing Science Teacher Preparedness for Sustainability and Energy Education: Development of a Readiness Index**	Sustainability Education (including Environmental and Health Education)
31	Vanda Janštová and Eva Krkavcová	**Reasons of Biology Major and Future Biology Teacher to Study Biology**	Students' Values, Attitudes and Decision-Making
32	Wilton Lodge, Alistair Newall, Michael Reiss and Emma Newall	**"THEY FELT SEEN IN THAT MOMENT": EXPLORING BIOLOGY TEACHERS' UNDERSTANDING OF THIRD SPACE PEDAGOGY**	Socioscientific Issues
35	Annkathrin Wenzel and Eva Gläser	**Biodiversity education and species knowledge – German primary school children's conceptions about birds**	Sustainability Education (including Environmental and Health Education)
36	Adva Shemi, Gilat Brill and Anat Yarden	**Bringing plankton research into the classroom: an essential step toward a climate literate society**	Sustainability Education (including Environmental and Health Education)
42	Anna Zelená and Vanda Janštová	**Understanding Interdisciplinary Topics in Science**	Sustainability Education (including Environmental and Health Education)
49	Inbal Ziv-Uziel, Nirit Lavie Alon and Tali Tal	**Investigating Teachers' Professional Development Programs on Climate Change Education**	Sustainability Education (including Environmental and Health Education)
56	Mats Lundström	**Upper secondary students' views of sexuality education**	Sustainability Education (including Environmental and Health Education)
67	Carola Garrecht, Barbara Jaun-Holderegger, Eric Wyss, Ueli Studhalter and Sebastian Tempelmann	**Rethinking Biodiversity Education: Early Insights from a Nationwide Teacher Training Initiative**	Sustainability Education (including Environmental and Health Education)
97	Pauline Book and Inger-Kristin Vie	**Agency in Interdisciplinary Sustainability Education in Primary School**	Sustainability Education (including Environmental and Health Education)
98	Ümran Betül Cebesoy	**EVOLUTION AS A SOCIOSCIENTIFIC ISSUE: PRE-SERVICE TEACHERS' REASONING ABOUT ANTIBIOTIC RESISTANCE**	Socioscientific Issues
99	Yılmaz Öden, Burcu Güngör Cabbar and Nazlı Ruya Taşkın Bedizel	**Addressing Biomass Misconceptions With Systems Thinking Models In Photosynthesis**	Sustainability Education (including Environmental and Health Education)
100	Nanna Villumsen and Camilla Blomgreen	**Enhancing Motivation in Biology and Pre-service Teachers' Professional Identities through Aesthetic Approaches**	Students' Values, Attitudes and Decision-Making
101	Cristina Gil Gonzalez and Beatriz Bravo Torija	**FUTURE TEACHERS' PERCEPTIONS ON THEIR HABILITY TO WORK ON FOOD EDUCATION IN CLASSROOM**	Sustainability Education (including Environmental and Health Education)
107	Sandra Carballeda, Ángela Bermejo and Rosa Gálvez	**Board game to raise awareness of emerging diseases spread by mosquitoes and sand flies in Spain**	Sustainability Education (including Environmental and Health Education)

115	Marinthe A. Meijer, Jelle N.A. Boeve-de Pauw and Marie-Christine P.J. Knippels	**Mapping How ESD Competences Are Assessed in Secondary Education: Implications for Teachers**	Sustainability Education (including Environmental and Health Education)
119	Finja Rath and Claas Wegner	**Spaces of efficacy: A mixed-methods study on perceived behavioral control in the context of an environmental education workshop**	Sustainability Education (including Environmental and Health Education)
122	Dagmar Vašutová	**STUDENTS' SATISFACTION WITH A WASTE-MANAGEMENT EVENT: AN EVALUATION OF THE "WASTE COMPETITION"**	Sustainability Education (including Environmental and Health Education)
123	Dominika Mlakar, Jelka Strgar and Žan Rode	**Knowledge about and attitude towards bees in grades 4 and 8 of primary school**	Students' Values, Attitudes and Decision-Making
133	Antonia Förster and Carolin Retzlaff-Fürst	**Exploring the Relationship between Nature Connectedness and Species Literacy in Ugandan Secondary School Students**	Sustainability Education (including Environmental and Health Education)
136	Sören Werner and Marcus Hammann	**Promoting nature connectedness through guided self-reflection on nature-based activities among secondary school biology students**	Sustainability Education (including Environmental and Health Education)
138	Rachel Davies	**TEACHING BIOLOGY: TALES FROM TWO CONTEXTS – A BOURDIEUSIAN ANALYSIS**	Socioscientific Issues
144	Marina Mota, Cristina Sá and Cecília Guerra	**SCIENCE COMICS AS INTERACTIVE DIDACTIC RESOURCES: IMPACTS ON NON-FORMAL SCIENCE EDUCATION CONTEXT**	Sustainability Education (including Environmental and Health Education)
146	Cecília Guerra, Zé Loureiro, David Oliveira and Joana Pereira	**USING VIDEO-BASED SCIENCE OUTREACH TO SUPPORT THE TEACHING AND LEARNING OF COMPLEX EPIGENETIC CONCEPTS**	Sustainability Education (including Environmental and Health Education)
148	Rebecka Fingalsson	**Un/easy – sexuality education and the productive force of feeling uncomfortable**	Socioscientific Issues
156	Aprillyana Dwi Utami, Andri Christodoulou and Marcus Grace	**IT'S A PARADOX – PRE-SERVICE BIOLOGY TEACHERS' PERSPECTIVES OF CULTURE-BASED SOCIO-SCIENTIFIC ISSUES**	Socioscientific Issues
167	Pirchia Tamar Waxman, Dana Sachyani, Areen Khalaily, Ravit Golan Duncan, Shoshna Herman, Moran Shalom, Bili Friedman and Michal Zion	**Integrating Social Justice in Biology Education: Exploring Health Disparities in Diabetes**	Socioscientific Issues
180	Ana Birsan, Irina Petcu, Liliana Morosan and Mariana Savva	**INTEGRATION OF NEW EDUCATION IN BIOLOGY TEACHING - A NEED REFLECTED IN THE VOICE OF STUDENTS**	Students' Values, Attitudes and Decision-Making
183	Paolo Lucas Sciascia, Sabine Meister and Annette Upmeier zu Belzen	**Situational Perception and Performance: Use of Prompts in Data-Based Decision-Making Tasks**	Students' Values, Attitudes and Decision-Making
190	Helen Semilarski and Helin Semilarski	**Navigating Current Information: An Investigation of Students' Online Information-Seeking Behavior**	Socioscientific Issues
195	Julia Rehkemper and Claas Wegner	**INVESTIGATING SELF-RELATED CONSTRUCTS IN GIRLS-ONLY GROUPS WITH BIOLOGY AND INFORMATICS CONTENT**	Socioscientific Issues
247	Sonja Enzinger-Mühlbacher and Nora Luschin-Ebengreuth	**Representations of Vertebrates and Invertebrates in School Biology Textbooks: A Qualitative Analysis**	Socioscientific Issues
258	Mercédes Avignon	**Citizenship education through science: which curricular coherence for upper secondary vocational education in French-speaking Belgium?**	Socioscientific Issues
261	Karoline Dütemeyer and Anna Beniermann	**Overcoming avoidance in teaching Controversial Science Issues: Theoretical considerations**	Socioscientific Issues

DAY 3 – THURSDAY, 27.8.

PAPER AND SYMPOSIUM SESSION 5 | 9.00 – 10.30

Room 1	Room 2	Room 3	Room 4	Room 5
102 **MAIN: Transforming Biology and Environmental Education through Citizen Science** Dina Tsybulsky and Tali Tal Outdoor and Informal Education Symposia	**127** **Measuring Students' Perceived Competence during Experimentation** Tim Kirchhoff, Matthias Wilde, Christoph Randler and Nadine Großmann Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	**91** **MAIN: Mechanistic reasoning in biology: Exploring processes, challenges, and educational Value** Michal Haskel-Ittah, Shanny Mishal-Morgenstern, Kostas Kampourakis, Julia Svoboda, Sugat Dabholkar, Scott Benjamin, Marina Orth and Benedikt Heuckmann Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Symposia	**120** **Fostering media competence in STEM learning through the creation of explanatory videos – an emprical comparisson** Carla Beckmann, Oliver Böhm-Kasper and Claas Wegner Teaching Strategies, Learning Environments and Digital Media Oral	**94** **Framing Action Competence for Climate Change: Insights from ESD and Applications in Biology Education** Arief Muttaqiin, Niklas Gericke and Daniel Olsson Sustainability Education (including Environmental and Health Education) Oral
40 **Learning Ecology Outdoors: Authentic Inquiry via Citizen Science** Nirit Lavie Alon, Tali Tal, Hila Shefet Barkae and Lavi Oren Outdoor and Informal Education Symposia	**236** **Fostering systems thinking and interdisciplinary understanding of photosynthesis through design-based learning in lower secondary education** Katrin Vaino, Konstantinos Korfiatis and Ana Valdmann Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	**71** **Black-boxes recognition as a crucial step in the process of mechanistic reasoning** Michal Haskel-Ittah and Shanny Mishal-Morgenstern Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Symposia	**149** **CHATGPT AS A TOOL TO SUPPORT SECONDARY SCHOOL STUDENTS IN FORMULATING RESEARCH QUESTIONS WITHIN A CRISPR-CAS BIOTECHNOLOGY RESEARCH LABORATORY CONTEXT.** Lies Vanden Broeck, Silke Sterck, Lieve Moeyersons and Marion Crauwels Teaching Strategies, Learning Environments and Digital Media Oral	**109** **Beliefs about sustainable and healthy nutrition among young students** Julia Holzer and Doris Elster Sustainability Education (including Environmental and Health Education) Oral
45 **Conceptualizing the Educational Value of Citizen Science for Fostering Scientific and Statistical Reasoning and NOS Understanding** Haya Ben Simon, Anna Pshenichny-Mamo and Dina Tsybulsky Outdoor and Informal Education Symposia	**79** **Valid Assessment of the Understanding of Nature of Science - A Systematic Literature Review** Sarah Wünsche, Leroy Großmann, Daniela Mahler and Bianca Reinisch Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	**90** **A Role for Individual-level Mechanisms in Developing Integrated Evolutionary Explanations** Julia Svoboda, Sugat Dabholkar and Scott Benjamin Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Symposia	**150** **ANALYZING GAZE BEHAVIOR AND COGNITIVE PROCESSES IN EXPERTS AND NOVICES WHEN VIEWING AN ANIMATION ON PCR** Silke Sterck, Amber Gregoor, Lies Vanden Broeck, Lieve Moeyersons, Bert Oben and Marion Crauwels Teaching Strategies, Learning Environments and Digital Media Oral	**116** **Action or Reflection? Developing an Instrument to Examine ESD Approaches Through Pre-Service Biology Teachers' Beliefs** Vivien Bernhardt and Matthias Wilde Sustainability Education (including Environmental and Health Education) Oral
46 **FLEBOCOLLECT: SCHOOL CITIZEN SCIENCE TO STUDY LEISHMANIOSIS DISEASE AUTHORS AND AFFILIATION** Rosa Gálvez, Ángela Bermejo and Ana I. Mora-Urda Outdoor and Informal Education Symposia	**230** **Designing a course to support primary school teacher students' understanding of the nature of science** Aigi Kikkas, Regina Soobard and Miia Rannikmäe Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Oral	**86** **The Effect of Mechanistic and Causal Explanations on Students' Risk Perception in a Foodborne One Health Context** Benedikt Heuckmann and Marina Orth Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS Symposia	**152** **From descriptive to predictive Biology - Exploration of K12-Students' Data Literacy in Biology Education** Tim Göddenhenrich and Benedikt Heuckmann Teaching Strategies, Learning Environments and Digital Media Oral	**126** **Collective over Individual? Patterns of action competence development through a climathon** Michiel van Harskamp, Marinthe Meijer, Marie-Christine P.J. Knippels and Jelle N.A. Boeve-de Pauw Sustainability Education (including Environmental and Health Education) Oral
72 **Designing for Expansive Learning: How Flexible Citizen Science Curricula Can Empower Students' Agency**		**Discussion led by Kostas Kampourakis**	**154** **ADDRESSING PLANT AWARENESS DISPARITY BY ENHANCING SCIENTIFIC PROCESS SKILLS AND PLANT KNOWLEDGE**	**141** **Extinction of Experience? To what extent do secondary school students (age 10-**

Room 1	Room 2	Room 3	Room 4	Room 5
Yael Kali, Ornit Sagy, Yael Bar Nes and Amram Eshel Outdoor and Informal Education Symposia			Marion Crauwels, Silke Sterck, Arthur Foqué, Robbe Mertens, Lieve Moeyersons and Lies Vanden Broeck Teacher Professionalization and PCK Oral	**18) have personally relevant nature experiences?** Marcus Hammann, Sören Werner and Helener Kesseler Sustainability Education (including Environmental and Health Education) Oral
102 **MAIN: Transforming Biology and Environmental Education through Citizen Science** Dina Tsybulsky and Tali Tal Outdoor and Informal Education Symposia				**59** **Promoting Sustainability through Plant-Based Education: Insights from a Narrative Literature Review** Alexandros Amprazis, Nikolaos Galanis, Anastasios Papanikolaou, Panagiota Christodoulou, Anastasia Oikonomou and Penelope Papadopoulou Sustainability Education (including Environmental and Health Education) Oral
163 **EXPLORING THE SUPPORT NEEDS OF TEACHERS AS FACILITATORS IN CITIZEN SCIENCE** Jelle Boeve-de Pauw and Bart de Groot Outdoor and Informal Education Symposia				

POSTER SESSION 3 | 11.00 – 12.30

Number	Authors	Title	Strand
5	Tetiana Krushynska and Jani Ursin	**AI-powered generating MCQs for assessments in biology**	Teaching Strategies, Learning Environments and Digital Media
19	Maria Jafari, Carolin Strehmel, Vanessa Meyer, Nunzia-Mintaah Karunainathan and Anke Meisert	**Student silence in digitally mediated SSI discussions**	Teaching Strategies, Learning Environments and Digital Media
23	Arvid Lobato Berg, Kristina Zinger and Carl-Johan Rundgren	**An Empirical Study of Upper Secondary Students' Learning with Visualizations of Hexokinase**	Teaching Strategies, Learning Environments and Digital Media
34	Rolf Saarna and Anne Laius	**Evaluating a Teacher Training Module on Energy and Sustainable Development: A Mixed-Methods Study of Competence Development in Education for Sustainable Development**	Teacher Professionalization and PCK
55	Iryna Kompanets, Sabine Roemer, Olga Molozhava, Oleksandr Savchenko, Stephanie Heimgartner and Kornelia Freitag	**AI-ENHANCED E-LEARNING IN WARTIME: ASSESSING THE DIDACTIC FEASIBILITY OF A GAMIFIED BIOCHEMISTRY COURSE IN UKRAINIAN UNIVERSITIES**	Teaching Strategies, Learning Environments and Digital Media
73	Maja Tomšič, Katja Malovrh, Jože Bavcon and Blanka Ravnjak	**Teacher professionalization programme on plant species conservation at the University Botanic Gardens Ljubljana**	Teacher Professionalization and PCK
114	Max Romanik and Claas Wegner	**Where can we foster STEM career aspirations? Empirically comparing an in-school and out-of-school learning place**	Teaching Strategies, Learning Environments and Digital Media
134	Marlin Penzenstadler, Melanie Basten, Sebastian Becker-Genschow, Katharina Groß, Kirsten Schlüter, Cristal Schult and Silvia Fränkel	**Learning for Sustainability with Digital Structured Inquiry**	Teaching Strategies, Learning Environments and Digital Media
147	Florian Macke and Anna Beniermann	**Teaching strategies and theories in school-based sleep education programmes – A literature review**	Sustainability Education (including Environmental and Health Education)
161	Ismi Rakhmawati, Lucas Weinberg, Alexander Lichius, Johanna Taglieber and Suzanne Kapelari	**HOW LEARNING TOOLS SHAPE REPRESENTATION? A COMPARATIVE STUDY IN VR AND MICROSCOPE SETTINGS**	Teaching Strategies, Learning Environments and Digital Media

169	Marie Neumann and Benedikt Heuckmann	**Technology-Related Enacted Beliefs in Biology Education: A Methodological Exploration of the Plan-Teach-Reflect Cycle**	Teacher Professionalization and PCK
172	Maxi Ritter and Armin Lude	**Investigating Biodiversity Challenges using an Educational Design Research Approach**	Sustainability Education (including Environmental and Health Education)
178	Katja Stanič and Andreja Špernjak	**Seeing the Unseen: Augmented Reality as a Tool for Learning Biology with Live Animals**	Teaching Strategies, Learning Environments and Digital Media
182	Lucas Weinberg, Johanna Nagl, Lena Warrelmann and Suzanne Kapelari	**Soil Health Education in Austria: Topics, Challenges and Needs. A Case Study**	Sustainability Education (including Environmental and Health Education)
191	Linda Hämmerle, Ella Guelmino and Eva Fraňková	**Climate Change Education in Austria's Teacher Education for Secondary Schools**	Sustainability Education (including Environmental and Health Education)
192	Veronika Winter, Linda Hämmerle and Jelle Boeve-de Pauw	**Pre-service biology teachers' beliefs, emotions and intention to implement climate change education**	Sustainability Education (including Environmental and Health Education)
196	Stiina Lõhmus and Anne Laius	**Integrating Bioart into Science Teacher Education: Bridging Science, Creativity, and Sustainability**	Teaching Strategies, Learning Environments and Digital Media
200	Katharina Düsing, Maike Sauer, Cornelia Averdunk and Alexander Bergmann-Gering	**CONTENT ANALYSIS OF TEACHERS' PERSONAL AND ENACTED PCK REGARDING CORE CONCEPTS AND SYSTEMS THINKING**	Teacher Professionalization and PCK
207	Sarah Lang and Lena von Kotzebue	**Serious Games for Climate Action: Opportunities & Challenges of Digital Game-Based Learning for Biology Teachers**	Teaching Strategies, Learning Environments and Digital Media
212	Nina Christenson	**USING THE RISK MATRIX AS A DIDACTICAL TOOL FOR TEACHING SOCIOSCIENTIFIC ISSUES IN SCIENCE EDUCATION**	Socioscientific Issues
218	Pål Kvello, Zhuo Li and Lars Lundheim	**A physical model of the nervous system systematically developed for increasing student motivation and understanding**	Teaching Strategies, Learning Environments and Digital Media
220	Philipp Behrens, Anke Meisert and Jürgen Menthe	**Potential of alternative experiment protocol structuring**	Writing, Speaking, Reading and Argumentation
222	Jana Schilbert and Annette Scheersoi	**Cultivating interest in sustainable nutrition: Exploring what makes nutrition education work**	Sustainability Education (including Environmental and Health Education)
228	Stella Mehl, Lars Dietrich and Kerstin Kremer	**Fostering Biodiversity Data Literacy Using Authentic Data Sets in Biology Education**	Teaching Strategies, Learning Environments and Digital Media
232	Svea Isabel Kleinert, Justin Timm, Nora Lösing, Carolyn Erben, Jan Koschorreck, Florian Leese, Antje Ullrich, Marie-Thérése Werner and Philipp Schmiemann	**Citizen science in freshwater research for students**	Sustainability Education (including Environmental and Health Education)
233	Maria Ilia, Periklis Kleitou, Nikolaos Doumpas, Christina Michail, Christina Diamantoupoulou, Demetris Kletou and Konstantinos Korfiatis	**SEAMIND: Improving knowledge, pro-environmental intentions, and connectedness to the sea through Field-Lab-Classroom integration**	Sustainability Education (including Environmental and Health Education)
234	Li Zhuo, Maren Skjelstad Fredagsvik, Anne Berit Johnsen and Pål Kvello	**Developing model-based teaching of the nervous system for pre-service teachers through Design-based research**	Teaching Strategies, Learning Environments and Digital Media
235	Kaire Jõgi and Aigi Kikkas	**Enhancing Continuity in Science Education: Aligning Early Childhood and Primary Teacher Education Programmes in Estonia**	Teacher Professionalization and PCK
239	Freya Steinacher, Theresa Hofstätter and Lena von Kotzebue	**DRIVERS OF SUSTAINABLE DIETARY INTENTIONS IN ADOLESCENTS**	Sustainability Education (including Environmental and Health Education)
243	Veronika Šilhavá and Jan Mourek	**PUBLIC INTEREST IN IDENTIFYING INVERTEBRATES IN THE MIRROR OF SOCIAL NETWORK GROUPS**	Sustainability Education (including Environmental and Health Education)
251	Nuno Afonso, Adriana Ferreira and Margarida M. Marques	**EXPLORATION OF GAMES AND GAMIFICATION IN THE THEMES OF ECOSYSTEMS AND DISASTERS IN 8TH GRADE STUDENTS**	Teaching Strategies, Learning Environments and Digital Media
252	Lars Dietrich, Roman Asshoff and Kerstin Kremer	**Defining Ecological Literacy as a Science Education Construct: Towards Conceptual Coherence and Operational Clarity**	Sustainability Education (including Environmental and Health Education)
253	Betina Lopes and Fredson Delgado	**BUILDING MICROSCOPES, BUILDING CAPACITY: REVERSE INNOVATION FOR SUSTAINABLE SCIENCE EDUCATION**	Teaching Strategies, Learning Environments and Digital Media
257	Philipp Flieger, Daniel Kaiser, Roman Asshoff, Urs M. Weber and Lars Dietrich	**Exploring plant perception in landscape images by eye-tracking**	Sustainability Education (including Environmental and Health Education)
259	Max Mannsperger, Sonja Schaal and Steffen Schaal	**Measuring TPACK competence**	Teaching Strategies, Learning Environments and Digital Media
260	Jure Mravlje, Ana Pšeničnik and Iztok Tomažič	**PRE-SERVICE BIOLOGY TEACHERS' VIEWS ON USING AI IN THEIR FUTURE PROFESSION: A PILOT STUDY**	Teaching Strategies, Learning Environments and Digital Media
270	Carina Mur-Spiegl and Suzanne Kapelari	**STEM in Austria: Designing effective learning materials for a new school subject.**	Teaching Strategies, Learning Environments and Digital Media
272	Emanuel Nestler and Carolin Retzlaff-Fürst	**Game-based learning of coastal ecology: An intervention study on the impact of GBL on students' intrinsic motivation**	Teaching Strategies, Learning Environments and Digital Media

273	Maren Junker and Sarah Dannemann	**Educational Reconstruction of Climate-regulating Functions of Plants**	Sustainability Education (including Environmental and Health Education)
274	Neil Hart-Camus	**Multispecies storytelling for transformative biology education in urban schools**	Sustainability Education (including Environmental and Health Education)

DAY 4 – FRIDAY, 28.8.

PAPER AND SYMPOSIUM SESSION 6 | 11.00 – 12.30

Room 1	Room 2	Room 3	Room 4	Room 5
130 **MAIN: Learning to Care: Transforming Biology Education through Biodiversity Awareness** Peter Pany and Dawn Lorraine Sanders Sustainability Education (including Environmental and Health Education) Symposia	**27** **CRITICAL THINKING CRITERIA FOR MANAGING MEDIA INFORMATION ON ANTIBIOTIC RESISTANCE** Inés Martínez-Pena, Blanca Puig, Rui Marques-Vieira and Araitz Uskola Socioscientific Issues Oral	**21** **Assessment in informal evolution education: A case-study** Joelyn de Lima, Despina Tsopoglou-Gkina and Penelope Papadopoulou Outdoor and Informal Education Oral	**65** **Enhancing Photosynthesis Literacy in Secondary Education: Evaluating a Framework-Based Teaching Design** Daniel Olsson, Anders Eriksson and Niklas Gericke Teaching Strategies, Learning Environments and Digital Media Oral	**271** **CHILD PARTICIPATION IN CLIMATE ASSEMBLIES: SUCCESS FACTORS AND INSIGHTS FROM A STUDY IN THE UK** Gisela Cebrián and Justin Dillon Sustainability Education (including Environmental and Health Education) Oral
64 **MINIATURE LANDSCAPES. A PROJECT OF ART & SCIENCE TO APPROACH BIODIVERSITY AT INITIAL TEACHER TRAINING** Marcia Eugenio-Gozalbo, Inés Ortega-Cubero, Rafael Suárez-López and Lars Dietrich Sustainability Education (including Environmental and Health Education) Symposia	**9** **Epistemic Emotions as Markers and Mechanisms in SSI Learning through Digital Curation** Remah Haj and Dina Tsybulsky Socioscientific Issues Oral		**80** **Change in Preservice Science Teachers' Technology-Related Beliefs: The Role of Domain-Specificity** Sarah Wilken and Benedikt Heuckmann Teaching Strategies, Learning Environments and Digital Media Oral	**246** **EMBEDDING ONE HEALTH SOCIO-SCIENTIFIC ISSUES IN SCIENCE CLASSROOMS: CO-DESIGN AND DISCOURSE PRACTICES BETWEEN SUBJECT MATTER EXPERTS AND PRE-SERVICE TEACHERS** Ulrich Hobusch, Petra Bezeljak Cerv, Uwe K. Simon, Benedikt Heuckmann, Gregor Torkar, Albert Zeyer, Sebastian Stuppan, Sascha Krebser, Franziska Messenboeck, Kerstin Kremer and Martin Scheuch Sustainability Education (including Environmental and Health Education) Oral
131 **Rethinking Aliveness: How Students Apply Characteristics of Life Across Kingdoms** Benno Dünser, Ivo Ponocny and Peter Pany Sustainability Education (including Environmental and Health Education) Symposia	**84** **THE ROLE OF PERSONAL ENGAGEMENT IN SCIENTISTS' DIDACTIC TRANSPOSITION OF BIOLOGICAL KNOWLEDGE** Daniel Manzoni-de-Almeida Socioscientific Issues Oral	**47** **Biology and environmental awareness through an adventure-based animated series for young children** Marida Ergazaki Outdoor and Informal Education Oral	**81** **A Theory of Planned Behavior Approach to Fostering Pre-Service Biology Teachers' Use of Digital Incremental Scaffolds** Margit Offermann, Nadine Großmann, Jörg Großschedl, Lea Gussen, Svea Isabel Kleinert, Ricarda Lohrsträter, Pascal Schaldach, Steffen Schaal, Rebekka Siedler and Matthias Wilde Teaching Strategies, Learning Environments and Digital Media Oral	**266** **Talking science over coffee – Identifying design features that foster interest and understanding of science** Julian Kokott and Annette Scheersoi Sustainability Education (including Environmental and Health Education) Oral
132 **BIODIVERCITY-ISLAND HOPPING – CHANGING ATTITUDES TOWARDS PLANTS AND INSECTS THROUGH ACTION** Lisa Anna Pernausl, Peter Pany, Andrea Möller and Peter Lampert Sustainability Education (including Environmental and Health Education) Symposia	**118** **Pre-Service Teachers and Diversity-Sensitive Biology Education: Perceptions and Challenges** Sara Hassunah and Arne Dittmer Socioscientific Issues Oral	**184** **From rules to discovery: sensory experience and relation to more-than-humans in scientific mediation at the botanical garden** Alain Sénécail, Laure Kloetzer and Julien Leuenberger Outdoor and Informal Education Oral	**105** **Rolling Dice in Parsimony: Cultivating Playful Tree-Thinking in Secondary Biology Education** Lorenz Boeckhorst and Roald Verhoeff Teaching Strategies, Learning Environments and Digital Media Oral	**262** **PLANTS IN ACTION AGAINST CLIMATE CHANGE** Renata Ryplova, Tomas Mrhalek, Zbynek Vacha and Tereza Brcakova Sustainability Education (including Environmental and Health Education) Oral
140	**158**	**213**	**108**	**197**

Room 1	Room 2	Room 3	Room 4	Room 5
A Sense of Wonder Towards Plant Life Harald Raaijmakers and Dawn Sanders Sustainability Education (including Environmental and Health Education) Symposia	**Structural and Content Aspects of Argumentative Writing by Fifth-Grade Students' on a Socio-Scientific Issue Concerning Human Health** Ofra Ifrah, Orit Ben Zvi Assaraf and Tom Bielik Socioscientific Issues Oral	**THREE LEVELS OF CHALLENGES TEACHER EDUCATORS ENCOUNTER BY INTEGRATING EDUCATION OUTSIDE THE CLASSROOM** Iva Frýzová and Natálie Čeplová Outdoor and Informal Education Oral	**EFFECT OF DIGITAL ACTIVITY ON HIGHT SCHOOL STUDENTS' UNDERSTANDING OF CHANCE AND EVOLUTION** Magali Coupaud, Claire Coiffard, Fabienne Paulin and Jérémie Touze Teaching Strategies, Learning Environments and Digital Media Oral	**Investigating Undergraduate Students' Conceptions of Circular Economy Practices** Maria Andronikou, Stella Petrou and Konstantinos Korfiatis Sustainability Education (including Environmental and Health Education) Oral
	165 **Framing Sexuality Education in Biology: A Qualitative Content Analysis of External Providers in Three Austrian Regions** Gudrun Kern and Uwe Simon Socioscientific Issues Oral	**214** **A model for reporting educational design research: insights from a case study on historic gardens** Daniel Emge and Volker Wenzel Outdoor and Informal Education Oral		

SUBMISSION LIST

Paper	Authors	Title	Type of presentation	Symposium No.	Strand	SCHEDULED
5	Tetiana Krushynska and Jani Ursin	**AI-powered generating MCQs for assessments in biology**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
7	Adiv Gal and Dana Sachyani	**Holistic Education through Hackathon: Enhancing 21st-Century Skills among Fifth Graders - A Case Study**	Oral		Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 5 | 11:00
8	Dana Sachyani and Adiv Gal	**Cultivating Climate Activist Teachers: Insights from a Course on Environmental Education and Action- A Case Study**	Oral		Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 5 | 11:15
9	Remah Haj and Dina Tsybulsky	**Epistemic Emotions as Markers and Mechanisms in SSI Learning through Digital Curation**	Oral		Socioscientific Issues	28.8.2026 | Room 2 | 11:15
11	Frederic Leterme, Jérémy Castéra, Magali Coupaud, Corinne Jégou, Carine Boyer, Nathalie Topalian, Solenne Albertini and Pierre-Olivier Thebault	**EVALUATING THE IMPACT OF E3D ECO-LABELING ON PRIMARY SCHOOL STUDENTS' ACTION COMPETENCE FOR SUSTAINABILITY: A PILOT STUDY**	Oral		Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 5 | 11:30
12	Araitz Uskola	**DEVELOPING PRESERVICE TEACHERS´ SYSTEMS THINKING BY ELABORATING NETWORKS OF IDEAS**	Poster		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	TUE 25.8.2026
14	Ana Valdmann	**Motivation, Preparation, and Learning Strategies in the Estonian Biology Olympiad: A Comparative Study Between Basic and Upper Secondary Students**	Poster		Students' Values, Attitudes and Decision-Making	WED 26.8.2026
15	Hlologelo Climant Khoza	**Examining the nature of biology teacher explanations and resulting student interaction: A topic-specific PCK analysis approach**	Poster		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	TUE 25.8.2026
16	Alexander Bergmann and Cornelia Averdunk	**EXPLORATORY STUDY ON SYSTEM-RELATED KNOWLEDGE OF PRE-SERVICE BIOLOGY TEACHERS**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	25.8.2026 | Room 4 | 11:15
17	Carl-Johan Rundgren, Maria Andrée, Cecilia Dudas, Kristin Persson and Josefin Reimark	**Developing capabilities for critical examination of biology-related issues in the media. A design-based study in upper secondary school**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	25.8.2026 | Room 4 | 11:30
18	Irene González Costa, Blanca Puig and Paloma Blanco Anaya	**From critical reasoning to critical action: A One Health Design-Based Research**	Poster		Socioscientific Issues	WED 26.8.2026
19	Maria Jafari, Carolin Strehmel, Vanessa Meyer, Nunzia-Mintaah Karunainathan and Anke Meisert	**Student silence in digitally mediated SSI discussions**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
20	Isabell K. Adler and Sebastian Tempelmann	**Primary school teachers' use of teleology and anthropomorphism to explain evolution**	Symposia	5: Pessoa: EVOLUTION EDUCATION IN THE EARLY YEARS	Conceptual change	25.8.2026 | Room 1 | 11:15
21	Joelyn de Lima, Despina Tsopoglou-Gkina and Penelope Papadopoulou	**Assessment in informal evolution education: A case-study**	Oral		Outdoor and Informal Education	28.8.2026 | Room 3 | 11:00
22	Bento Cavadas and Bruno Sousa	**Representations of evolution in Portuguese science textbooks**	Poster		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	TUE 25.8.2026
23	Arvid Lobato Berg, Kristina Zinger and Carl-Johan Rundgren	**An Empirical Study of Upper Secondary Students' Learning with Visualizations of Hexokinase**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
24	Cigdem Han Tosunoglu, Justus Schöller and Annette Upmeier Zu Belzen	**TEACHERS AS AGENTS OF CHANGE: MOTIVATION AND AGENCY FOR TEACHING CLIMATE CHANGE**	Oral		Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 5 | 11:45
25	Justus Braune, Cathérine Conradty, Franz Xaver Bogner and Jürgen Paul	**REVOLUTIONIZING QUALITATIVE RESEARCH: AI-ASSISTED ANALYSIS OF STUDENT CONCEPTIONS ON MICROPLASTICS**	Oral		Conceptual change	25.8.2026 | Room 2 | 11:00
26	Shiyu Xu, Michael Reiss and Wilton Lodge	**Designing Inquiry-based Teaching to Enhance Students' Scientific Creativity: A Case Study with a Chinese Biology Teacher**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	25.8.2026 | Room 4 | 11:45
27	Inés Martínez-Pena, Blanca Puig, Rui Marques-Vieira and Araitz Uskola	**CRITICAL THINKING CRITERIA FOR MANAGING MEDIA INFORMATION ON ANTIBIOTIC RESISTANCE**	Oral		Socioscientific Issues	28.8.2026 | Room 2 | 11:00
28	Anne Laius and Rolf Saarna	**Assessing Science Teacher Preparedness for Sustainability and Energy Education: Development of a Readiness Index**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
30	Milan Kubiatko	**The storks are still homosexuals or pupils and students' ideas about basic zoological concepts**	Poster		Conceptual change	TUE 25.8.2026
31	Vanda Janštová and Eva Krkavcová	**Reasons of Biology Major and Future Biology Teacher to Study Biology**	Poster		Students' Values, Attitudes and Decision-Making	WED 26.8.2026
32	Wilton Lodge, Alistair Newall, Michael Reiss and Emma Newall	**"THEY FELT SEEN IN THAT MOMENT": EXPLORING BIOLOGY TEACHERS' UNDERSTANDING OF THIRD SPACE PEDAGOGY**	Poster		Socioscientific Issues	WED 26.8.2026
33	Nico Tuncel, Rieß Werner and Maik Beege	**Promoting Systems Thinking: The Effects of Instructional Guidance in the Combined Use of Digital System Models**	Oral		Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 5 | 12:00

34	Rolf Saarna and Anne Laius	**Evaluating a Teacher Training Module on Energy and Sustainable Development: A Mixed-Methods Study of Competence Development in Education for Sustainable Development**	Poster		Teacher Professionalization and PCK	THU 27.8.2026
35	Annkathrin Wenzel and Eva Gläser	**Biodiversity education and species knowledge – German primary school children's conceptions about birds**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
36	Adva Shemi, Gilat Brill and Anat Yarden	**Bringing plankton research into the classroom: an essential step toward a climate literate society**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
37	Maja Funke, René Leubecher and Jörg Zabel	**Passed the Test? Competence Assessment in German Biology Abitur Tasks**	Poster		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	TUE 25.8.2026
38	Cora Cohen-Azria	**The Wolf : Neither Good nor Evil. A Case Study of a Museum Exhibition as a Didactic Device to Explore Children's Relationship to Animals and the Construction of Scientific Knowledge**	Oral		Outdoor and Informal Education	28.8.2026 | Room 3 | 11:15
39	Till Schmäing, Leo Siiman, Natalie Baumgartner Hirscher, Marlene Ganz, Moritz Krell, Holger Meeh, Sergios Nicolaou, Marios Papaevripidou, Yvoni Pavlou, Iris Schiffl, Martina Schuknecht, Simone Suppert, Tanja Thumann, Armin Baur and Andreas Lampis	**Professional Development for Inquiry-Based Learning: What Content Matters to Pre-service and In-service Biology Teachers?**	Oral		Teaching Strategies, Learning Environments and Digital Media	26.8.2026 | Room 3 | 12:00
40	Nirit Lavie Alon, Tali Tal, Hila Shefet Barkae and Lavi Oren	**Learning Ecology Outdoors: Authentic Inquiry via Citizen Science**	Symposia	1: Tsybulsky: Transforming Biology and Environmental Education through Citizen Science	Outdoor and Informal Education	27.8.2026 | Room 1 | 09:15
41	Hanna Wanselin and Kristina Danielsson	**Students' meaning-making in ecology education**	Oral		Writing, Speaking, Reading and Argumentation	26.8.2026 | Room 2 | 09:00
42	Anna Zelená and Vanda Janštová	**Understanding Interdisciplinary Topics in Science**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
43	Thomas Gabor, Katharina Düsing and Ute Harms	**The Experiment Design Toolbox: A Novel Task Format for Assessing Competencies in Planning Experiments**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	25.8.2026 | Room 4 | 11:00
45	Haya Ben Simon, Anna Pshenichny-Mamo and Dina Tsybulsky	**Conceptualizing the Educational Value of Citizen Science for Fostering Scientific and Statistical Reasoning and NOS Understanding**	Symposia	1: Tsybulsky: Transforming Biology and Environmental Education through Citizen Science	Outdoor and Informal Education	27.8.2026 | Room 1 | 09:30
46	Rosa Gálvez, Ángela Bermejo and Ana I. Mora-Urda	**FLEBOCOLLECT: SCHOOL CITIZEN SCIENCE TO STUDY LEISHMANIOSIS** **DISEASE AUTHORS AND AFFILIATION**	Symposia	1: Tsybulsky: Transforming Biology and Environmental Education through Citizen Science	Outdoor and Informal Education	27.8.2026 | Room 1 | 09:45
47	Marida Ergazaki	**Biology and environmental awareness through an adventure-based animated series for young children**	Oral		Outdoor and Informal Education	28.8.2026 | Room 3 | 11:30
48	Francois Lombard, Sudriès Marie, Larpin Camille and Weiss Laura	**Why Don't They Get It? Identifying and Explaining Slow Spots in Explanation Progress**	Oral		Conceptual change	25.8.2026 | Room 2 | 11:15
49	Inbal Ziv-Uziel, Nirit Lavie Alon and Tali Tal	**Investigating Teachers' Professional Development Programs on Climate Change Education**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
50	Yael Shtechman and Michal Haskel-Ittah	**Mechanistic Reasoning as a Lens on Children's Plant Awareness**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	25.8.2026 | Room 4 | 12:00
52	Jessica León Paredes, Cristina Valares Masa, Jesús Gómez Ochoa de Alda, María Rocío Esteban Gallego and José María Marcos Merino	**DRAWINGS OF MICROORGANISMS BY PRESCHOOL STUDENTS: DESIGN OF** **AN ANALYSIS RUBRIC AND COMPARISON BETWEEN HUMAN AND ARTIFICIAL INTELLIGENCE EVALUATIONS**	Poster		Conceptual change	TUE 25.8.2026
53	Laura Colucci-Gray and Jonathan Hancock	**"It feels like I'm touching the soil!" STEAM Gardens for a transdisciplinary and transformative science education**	Symposia	2: Dillon: Culturally Responsive Biology Education	Socioscientific Issues	25.8.2026 | Room 1 | 16:15
54	Eliza Rybska and Wiktoria Michalak	**Exploring Primary Pupils' Understanding of the Immune System Using Drawing Tasks and Semi-Structured Interviews**	Oral		Conceptual change	25.8.2026 | Room 2 | 11:30
55	Iryna Kompanets, Sabine Roemer, Olga Molozhava, Oleksandr Savchenko, Stephanie Heimgartner and Kornelia Freitag	**AI-ENHANCED E-LEARNING IN WARTIME: ASSESSING THE DIDACTIC FEASIBILITY OF A GAMIFIED BIOCHEMISTRY COURSE IN UKRAINIAN UNIVERSITIES**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
56	Mats Lundström	**Upper secondary students' views of sexuality education**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
57	Karin Hecke and Isabel Jiménez Bargalló	**PRE-SERVICE PRIMARY SCHOOL TEACHERS PERCEPTIONS AND PREPAREDNESS TO PLAN BIOLOGY AS INQUIRY**	Oral		Teacher Professionalization and PCK	26.8.2026 | Room 4 | 09:00
58	Justin Dillon and Wilton Lodge	**MAIN: Culturally Responsive Biology Education**	Symposia	2: Dillon: Culturally Responsive Biology Education	Socioscientific Issues	25.8.2026 | Room 1 | 16:00
59	Alexandros Amprazis, Nikolaos Galanis, Anastasios Papanikolaou, Panagiota Christodoulou, Anastasia	**Promoting Sustainability through Plant-Based Education: Insights from a Narrative Literature Review**	Oral		Sustainability Education (including Environmental and Health Education)	27.8.2026 | Room 5 | 10:15

	Oikonomou and Penelope Papadopoulou					
60	Penelope Papadopoulou, Alexandros Amprazis and Despina Tsopoglou-Gina	**TEACHING AND LEARNING EVOLUTION IN EARLY CHILDHOOD EDUCATION: A MAPPING LITERATURE REVIEW**	Symposia	5: Pessoa: EVOLUTION EDUCATION IN THE EARLY YEARS	Conceptual change	25.8.2026 | Room 1 | 11:30
61	Asloum Nina, Murillo Audrey, Del Corso Jean-Pierre and Gallai Nicola	**TRANSFORMING CLIMATE REPRESENTATIONS: EXPERIENTIAL TOOLS IN AGRICULTURAL EDUCATION**	Oral		Conceptual change	25.8.2026 | Room 2 | 11:45
62	Katja Malovrh, Maja Tomšič, Blanka Ravnjak and Jože Bavcon	**Teaching methods used in the University Botanic Gardens Ljubljana**	Poster		Outdoor and Informal Education	TUE 25.8.2026
63	Pauline Sommerer, Helena Aptyka and Jörg Großschedl	**FOSTERING AND LINKING REFLECTION AND RESEARCH COMPETENCE AMONG PRESERVICE BIOLOGY TEACHERS**	Oral		Teacher Professionalization and PCK	26.8.2026 | Room 4 | 09:15
64	Marcia Eugenio-Gozalbo, Inés Ortega-Cubero, Rafael Suárez-López and Lars Dietrich	**MINIATURE LANDSCAPES. A PROJECT OF ART & SCIENCE TO APPROACH BIODIVERSITY AT INITIAL TEACHER TRAINING**	Symposia	6: Pany: Learning to Care: Transforming Biology Education through Biodiversity Awareness	Sustainability Education (including Environmental and Health Education)	28.8.2026 | Room 1 | 11:15
65	Daniel Olsson, Anders Eriksson and Niklas Gericke	**Enhancing Photosynthesis Literacy in Secondary Education: Evaluating a Framework-Based Teaching Design**	Oral		Teaching Strategies, Learning Environments and Digital Media	28.8.2026 | Room 4 | 11:15
66	Deborah Kelemen, Sarah Brown, Alden Burnham, Eli Elster, Léa Combette, Gillian Puttick, Sally Crissman and Sara Lacy	**Big Ideas in elementary school: A new curriculum for learning about evolution by natural selection in third grade (Symposium: Evolution Education in Early Years)**	Symposia	5: Pessoa: EVOLUTION EDUCATION IN THE EARLY YEARS	Conceptual change	25.8.2026 | Room 1 | 11:45
67	Carola Garrecht, Barbara Jaun-Holderegger, Eric Wyss, Ueli Studhalter and Sebastian Tempelmann	**Rethinking Biodiversity Education: Early Insights from a Nationwide Teacher Training Initiative**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
68	Jitka Kopecká	**Reflection, PCK, and professional vision: Insights from pre-service biology teachers' practice**	Oral		Teacher Professionalization and PCK	26.8.2026 | Room 4 | 09:30
69	Kate D. Molina-Gallo, Daniel Olsson, Teresa Berglund and Niklas Gericke	**NATURE IN SWEDISH LOWER SECONDARY BIOLOGY: WESTERN HEGEMONY OR PLURIVERSALITY?**	Oral		Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 5 | 16:00
70	Julia Zdunek and Jörg Zabel	**Tell me more about plants!**	Oral		Writing, Speaking, Reading and Argumentation	26.8.2026 | Room 2 | 09:15
71	Michal Haskel-Ittah and Shanny Mishal-Morgenstern	**Black-boxes recognition as a crucial step in the process of mechanistic reasoning**	Symposia	3: Morgenstern: Mechanistic reasoning in biology: Exploring processes, challenges, and educational Value	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	27.8.2026 | Room 3 | 09:15
72	Yael Kali, Ornit Sagy, Yael Bar Nes and Amram Eshel	**Designing for Expansive Learning: How Flexible Citizen Science Curricula Can Empower Students' Agency**	Symposia	1: Tsybulsky: Transforming Biology and Environmental Education through Citizen Science	Outdoor and Informal Education	27.8.2026 | Room 1 | 10:00
73	Maja Tomšič, Katja Malovrh, Jože Bavcon and Blanka Ravnjak	**Teacher professionalization programme on plant species conservation at the University Botanic Gardens Ljubljana**	Poster		Teacher Professionalization and PCK	THU 27.8.2026
74	Petra Olschewski, Helena Aptyka, Maren Flottmann, Corinne Wacker, Sandra Vamos and Kirsten Schlüter	**Development and validation of a nutrition questionnaire based on KAP and HBM**	Oral		Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 5 | 16:15
75	Wanda Sass and Jelle Boeve-de Pauw	**Supporting Coping Strategies through Emotion-sensitive Climate Change Education**	Oral		Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 5 | 16:30
76	Laura Härter and Jörg Prof. Dr. Zabel	**Together for Insects? Fostering Students' Agency for Insect Conservation through Collective Action**	Oral		Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 5 | 16:45
77	Lucie Tournayre, Nikos Tsourakis and Kostas Kampourakis	**Exploring how the concept "adaptation" is defined in scientific articles using text mining**	Symposia	4: Harms: Advancing Evolution Learning – Novel Conceptual and Methodological Approaches to Evolution Education	Conceptual change	26.8.2026 | Room 1 | 11:15
78	Lucie Tournayre, Nikos Tsourakis, Nuno Ribeiro Galheto, Alicia Sanchez-Mazas, Mathias Currat, Jose Nunes and Kostas Kampourakis	**How is "ancestry" conceptualized in the journal PLOS Genetics?**	Symposia	4: Harms: Advancing Evolution Learning – Novel Conceptual and Methodological Approaches to Evolution Education	Conceptual change	26.8.2026 | Room 1 | 09:00
79	Sarah Wünsche, Leroy Großmann, Daniela Mahler and Bianca Reinisch	**Valid Assessment of the Understanding of Nature of Science - A Systematic Literature Review**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	27.8.2026 | Room 2 | 09:45
80	Sarah Wilken and Benedikt Heuckmann	**Change in Preservice Science Teachers' Technology-Related Beliefs: The Role of Domain-Specificity**	Oral		Teaching Strategies, Learning Environments and Digital Media	28.8.2026 | Room 4 | 11:30
81	Margit Offermann, Nadine Großmann, Jörg Großschedl, Lea Gussen, Svea Isabel Kleinert, Ricarda Lohrsträter, Pascal Schaldach, Steffen Schaal, Rebekka Siedler and Matthias Wilde	**A Theory of Planned Behavior Approach to Fostering Pre-Service Biology Teachers' Use of Digital Incremental Scaffolds**	Oral		Teaching Strategies, Learning Environments and Digital Media	28.8.2026 | Room 4 | 11:45

82	Maren Skjelstad Fredagsvik, Ragnhild Lyngved Staberg, Hilde Ervik and Vibeke Gilje Sanne	**Exploring pre-service teachers' choices of sustainability topic: Implications for hope and action competence**	Oral		Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 5 | 17:00
83	Daniel Manzoni-de-Almeida and Patricia Marzin-Janvier	**UNDERSTANDING TEACHER TRAINEES' CRITICAL CHOICES IN APPLYING INQUIRY-BASED LEARNING ACTIVITIES IN BIOLOGY CLASSROOMS**	Oral		Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 5 | 17:15
84	Daniel Manzoni-de-Almeida	**THE ROLE OF PERSONAL ENGAGEMENT IN SCIENTISTS' DIDACTIC TRANSPOSITION OF BIOLOGICAL KNOWLEDGE**	Oral		Socioscientific Issues	28.8.2026 | Room 2 | 11:30
85	Ronja Sowinski, Finja Grospietsch and Moritz Krell	**Biology Teachers as Change Agents - Potentials for Transfer of Digitally-Supported Scientific Inquiry**	Oral		Teacher Professionalization and PCK	26.8.2026 | Room 4 | 09:45
86	Benedikt Heuckmann and Marina Orth	**The Effect of Mechanistic and Causal Explanations on Students' Risk Perception in a Foodborne One Health Context**	Symposia	3: Morgenstern: Mechanistic reasoning in biology: Exploring processes, challenges, and educational Value	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	27.8.2026 | Room 3 | 09:30
87	Abigail London and Michal Haskel-Ittah	**CAUSAL PROBLEMS IN EVERYDAY LAY REASONING: CONNECTING GOALS OF USE WITH INFORMATION TYPES**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	25.8.2026 | Room 3 | 16:00
88	Karen Waskewitz and Michal Haskel Ittah	**Shifting between Mechanistic and Narrative Reasoning – Towards a dynamic view of Cognitive Construals?**	Poster		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	TUE 25.8.2026
89	Ute Harms	**MAIN: Advancing Evolution Learning – Novel Conceptual and Methodological Approaches to Evolution Education**	Symposia	4: Harms: Advancing Evolution Learning – Novel Conceptual and Methodological Approaches to Evolution Education	Conceptual change	26.8.2026 | Room 1 | 11:00
90	Julia Svoboda, Sugat Dabholkar and Scott Benjamin	**A Role for Individual-level Mechanisms in Developing Integrated Evolutionary Explanations**	Symposia	3: Morgenstern: Mechanistic reasoning in biology: Exploring processes, challenges, and educational Value	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	27.8.2026 | Room 3 | 09:45
91	Michal Haskel-Ittah, Shanny Mishal-Morgenstern, Tamar Fuhrmann, Brendan Henrique, Julia Svoboda, Sugat Dabholkar, Scott Benjamin, Marina Orth and Benedikt Heuckmann	**MAIN: Mechanistic reasoning in biology: Exploring processes, challenges, and educational Value**	Symposia	3: Morgenstern: Mechanistic reasoning in biology: Exploring processes, challenges, and educational Value	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	27.8.2026 | Room 3 | 09:00
92	Isabel Jiménez-Bargalló and Jordi Martí-Feixas	**IDENTIFYING PRECONCEPTIONS IN DEVELOPMENTAL ASPECTS OF EVOLUTION**	Oral		Conceptual change	25.8.2026 | Room 2 | 12:00
93	Zeqir Veselaj and Besiana Gashi	**ANALYZING BIOLOGY TEXTBOOK QUESTION DESIGN AND STUDENT LEARNING OUTCOMES IN KOSOVO CLASSROOMS**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	25.8.2026 | Room 3 | 16:15
94	Arief Muttaqiin, Niklas Gericke and Daniel Olsson	**Framing Action Competence for Climate Change: Insights from ESD and Applications in Biology Education**	Oral		Sustainability Education (including Environmental and Health Education)	27.8.2026 | Room 5 | 09:00
95	Merav Siani, Asaf Salman, Moriah Ariely, Giora Alexandron and Anat Yarden	**Using Machine Learning to Assess Students' Responses to Evolution Scientific Explanation Questions**	Symposia	4: Harms: Advancing Evolution Learning – Novel Conceptual and Methodological Approaches to Evolution Education	Conceptual change	26.8.2026 | Room 1 | 09:15
96	Simon Blauza, Kerstin Kremer and Benedikt Heuckmann	**Simulations as epistemic tools: A machine learning-based analysis of students' uncertainty descriptions**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	25.8.2026 | Room 3 | 16:30
97	Pauline Book and Inger-Kristin Vie	**Agency in Interdisciplinary Sustainability Education in Primary School**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
98	Ümran Betül Cebesoy	**EVOLUTION AS A SOCIOSCIENTIFIC ISSUE: PRE-SERVICE TEACHERS' REASONING ABOUT ANTIBIOTIC RESISTANCE**	Poster		Socioscientific Issues	WED 26.8.2026
99	Yılmaz Öden, Burcu Güngör Cabbar and Nazlı Ruya Taşkın Bedizel	**Addressing Biomass Misconceptions With Systems Thinking Models In Photosynthesis**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
100	Nanna Villumsen and Camilla Blomgreen	**Enhancing Motivation in Biology and Pre-service Teachers' Professional Identities through Aesthetic Approaches**	Poster		Students' Values, Attitudes and Decision-Making	WED 26.8.2026
101	Cristina Gil Gonzalez and Beatriz Bravo Torija	**FUTURE TEACHERS' PERCEPTIONS ON THEIR HABILITY TO WORK ON FOOD EDUCATION IN CLASSROOM**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
102	Dina Tsybulsky and Tali Tal	**MAIN: Transforming Biology and Environmental Education through Citizen Science**	Symposia	1: Tsybulsky: Transforming Biology and Environmental Education through Citizen Science	Outdoor and Informal Education	27.8.2026 | Room 1 | 09:00
103	Stephen Price and Ralph Levinson	**Making Systems Visible Without Reification: A Relational Process Systems Framework**	Poster		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	TUE 25.8.2026
105	Lorenz Boeckhorst and Roald Verhoeff	**Rolling Dice in Parsimony: Cultivating Playful Tree-Thinking in Secondary Biology Education**	Oral		Teaching Strategies, Learning Environments and Digital Media	28.8.2026 | Room 4 | 12:00
106	Gur Arie Livni Alcasid and Iris Tabak	**A Window into Epistemic Practices of an Online Fitness Community**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	25.8.2026 | Room 3 | 16:45
107	Sandra Carballeda, Ángela Bermejo and Rosa Gálvez	**Board game to raise awareness of emerging diseases spread by mosquitoes and sand flies in Spain**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026

108	Magali Coupaud, Claire Coiffard, Fabienne Paulin and Jérémie Touze	**EFFECT OF DIGITAL ACTIVITY ON HIGHT SCHOOL STUDENTS' UNDERSTANDING OF CHANCE AND EVOLUTION**	Oral		Teaching Strategies, Learning Environments and Digital Media	28.8.2026 | Room 4 | 12:15
109	Julia Holzer and Doris Elster	**Beliefs about sustainable and healthy nutrition among young students**	Oral		Sustainability Education (including Environmental and Health Education)	27.8.2026 | Room 5 | 09:15
110	Tamar Fuhrmann and Brendan Henrique	**FROM CODE TO CHLOROPLASTS: MODELING AS A LANGUAGE FOR MECHANISTIC REASONING IN SCIENCE**	Symposia	3: Morgenstern: Mechanistic reasoning in biology: Exploring processes, challenges, and educational Value	Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	27.8.2026 | Room 3 | 10:00
111	Mario Schmiedebach and Claas Wegner	**Bridging the Dimensional Gap: Comparing 2D and Simplified 3D Models for Teaching Translation - A Design-Based Research Project**	Oral		Teaching Strategies, Learning Environments and Digital Media	27.8.2026 | Room 4 | 09:00
112	Pascal Schaldach, Matthias Wilde and Tim Kirchhoff	**Exploring the qualities of nature experiences across urban and rural learning environments**	Poster		Outdoor and Informal Education	TUE 25.8.2026
113	Leroy Großmann and Bianca Reinisch	**BIOLOGY TEACHERS' CURRICULAR KNOWLEDGE. MINDING THE GAP BETWEEN OFFICIAL AND IMPLEMENTED CURRICULUM?**	Oral		Teacher Professionalization and PCK	25.8.2026 | Room 4 | 16:30
114	Max Romanik and Claas Wegner	**Where can we foster STEM career aspirations? Empirically comparing an in-school and out-of-school learning place**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
115	Marinthe A. Meijer, Jelle N.A. Boeve-de Pauw and Marie-Christine P.J. Knippels	**Mapping How ESD Competences Are Assessed in Secondary Education: Implications for Teachers**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
116	Vivien Bernhardt and Matthias Wilde	**Action or Reflection? Developing an Instrument to Examine ESD Approaches Through Pre-Service Biology Teachers' Beliefs**	Oral		Sustainability Education (including Environmental and Health Education)	27.8.2026 | Room 5 | 09:30
117	Gregor Torkar and Špela Klofutar	**BEYOND THE CLASSROOM: BIODIVERSITY IN ACTION**	Poster		Outdoor and Informal Education	TUE 25.8.2026
118	Sara Hassunah and Arne Dittmer	**Pre-Service Teachers and Diversity-Sensitive Biology Education: Perceptions and Challenges**	Oral		Socioscientific Issues	28.8.2026 | Room 2 | 11:45
119	Finja Rath and Claas Wegner	**Spaces of efficacy: A mixed-methods study on perceived behavioral control in the context of an environmental education workshop**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
120	Carla Beckmann, Oliver Böhm-Kasper and Claas Wegner	**Fostering media competence in STEM learning through the creation of explanatory videos – an emprical comparisson**	Oral		Teaching Strategies, Learning Environments and Digital Media	27.8.2026 | Room 4 | 09:15
122	Dagmar Vašutová	**STUDENTS' SATISFACTION WITH A WASTE-MANAGEMENT EVENT: AN EVALUATION OF THE "WASTE COMPETITION"**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
123	Dominika Mlakar, Jelka Strgar and Žan Rode	**Knowledge about and attitude towards bees in grades 4 and 8 of primary school**	Poster		Students' Values, Attitudes and Decision-Making	WED 26.8.2026
125	Carole Chappuis	**Action-Oriented Teaching for Biodiversity: Exploring Dynamics of Change**	Symposia	7: Lampert: Action-Oriented Teaching for Biodiversity: Exploring Dynamics of Change	Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 3 | 11:15
126	Michiel van Harskamp, Marinthe Meijer, Marie-Christine P.J. Knippels and Jelle N.A. Boeve-de Pauw	**Collective over Individual? Patterns of action competence development through a climathon**	Oral		Sustainability Education (including Environmental and Health Education)	27.8.2026 | Room 5 | 09:45
127	Tim Kirchhoff, Matthias Wilde, Christoph Randler and Nadine Großmann	**Measuring Students' Perceived Competence during Experimentation**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	27.8.2026 | Room 2 | 09:15
128	Johanna Aringer, Kristina Danielsson, Ammie Berglund and Lars Wallner	**Creation of Comics as Evolutionary Arenas: Tracing Reasoning Across Modes**	Oral		Writing, Speaking, Reading and Argumentation	26.8.2026 | Room 2 | 09:30
129	Lara Amorim and Betina Lopes	**DEVELOPING BIOLOGY TEACHERS' PCK THROUGH INQUIRY-BASED MICROBIOLOGY: INSIGHTS FROM A TRAINING PROGRAMME**	Oral		Teacher Professionalization and PCK	26.8.2026 | Room 2 | 11:00
130	Peter Pany and Dawn Lorraine Sanders	**MAIN: Learning to Care: Transforming Biology Education through Biodiversity Awareness**	Symposia	6: Pany: Learning to Care: Transforming Biology Education through Biodiversity Awareness	Sustainability Education (including Environmental and Health Education)	28.8.2026 | Room 1 | 11:00
131	Benno Dünser, Ivo Ponocny and Peter Pany	**Rethinking Aliveness: How Students Apply Characteristics of Life Across Kingdoms**	Symposia	6: Pany: Learning to Care: Transforming Biology Education through Biodiversity Awareness	Sustainability Education (including Environmental and Health Education)	28.8.2026 | Room 1 | 11:30
132	Lisa Anna Pernausl, Peter Pany, Andrea Möller and Peter Lampert	**BIODIVERCITY-ISLAND HOPPING – CHANGING ATTITUDES TOWARDS PLANTS AND INSECTS THROUGH ACTION**	Symposia	6: Pany: Learning to Care: Transforming Biology Education through Biodiversity Awareness	Sustainability Education (including Environmental and Health Education)	28.8.2026 | Room 1 | 11:45
133	Antonia Förster and Carolin Retzlaff-Fürst	**Exploring the Relationship between Nature Connectedness and Species Literacy in Ugandan Secondary School Students**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
134	Marlin Penzenstadler, Melanie Basten, Sebastian Becker-Genschow, Katharina Groß, Kirsten Schlüter, Cristal Schult and Silvia Fränkel	**Learning for Sustainability with Digital Structured Inquiry**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
135	Jana Quinte, Catherine Boyer, Denise Orange and Christian Orange	**SEXUAL REPRODUCTION OF FLOWERING PLANTS AND SCIENTIFIC EDUCATION OF FUTURE TEACHERS – A CASE STUDY**	Poster		Conceptual change	TUE 25.8.2026

136	Sören Werner and Marcus Hammann	**Promoting nature connectedness through guided self-reflection on nature-based activities among secondary school biology students**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
137	Netta Dagan, Masha Tsaushu and Tali Tal	**Between Belief and Curriculum: Teaching Evolution in a Religiously Diverse Society**	Poster		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	TUE 25.8.2026
138	Rachel Davies	**TEACHING BIOLOGY: TALES FROM TWO CONTEXTS – A BOURDIEUSIAN ANALYSIS**	Poster		Socioscientific Issues	WED 26.8.2026
139	Florian Stern, Lucie Tournayre, Marco Barroca-Paccard and Kostas Kampourakis	**How do pre-service biology teachers construe "adaptation"? Eliciting personal constructs using the repertory grid method**	Symposia	4: Harms: Advancing Evolution Learning – Novel Conceptual and Methodological Approaches to Evolution Education	Conceptual change	26.8.2026 | Room 1 | 09:30
140	Harald Raaijmakers and Dawn Sanders	**A Sense of Wonder Towards Plant Life**	Symposia	6: Pany: Learning to Care: Transforming Biology Education through Biodiversity Awareness	Sustainability Education (including Environmental and Health Education)	28.8.2026 | Room 1 | 12:00
141	Marcus Hammann, Sören Werner and Helener Kesseler	**Extinction of Experience? To what extent do secondary school students (age 10-18) have personally relevant nature experiences?**	Oral		Sustainability Education (including Environmental and Health Education)	27.8.2026 | Room 5 | 10:00
144	Marina Mota, Cristina Sá and Cecília Guerra	**SCIENCE COMICS AS INTERACTIVE DIDACTIC RESOURCES: IMPACTS ON NON-FORMAL SCIENCE EDUCATION CONTEXT**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
145	Dina Bartov and Anat Yarden	**Integrating Mathematics into Middle-School Biology Lessons: Teachers' Pathways to Change**	Oral		Teacher Professionalization and PCK	26.8.2026 | Room 2 | 11:15
146	Cecília Guerra, Zé Loureiro, David Oliveira and Joana Pereira	**USING VIDEO-BASED SCIENCE OUTREACH TO SUPPORT THE TEACHING AND LEARNING OF COMPLEX EPIGENETIC CONCEPTS**	Poster		Sustainability Education (including Environmental and Health Education)	WED 26.8.2026
147	Florian Macke and Anna Beniermann	**Teaching strategies and theories in school-based sleep education programmes – A literature review**	Poster		Sustainability Education (including Environmental and Health Education)	THU 27.8.2026
148	Rebecka Fingalsson	**Un/easy – sexuality education and the productive force of feeling uncomfortable**	Poster		Socioscientific Issues	WED 26.8.2026
149	Lies Vanden Broeck, Silke Sterck, Lieve Moeyersons and Marion Crauwels	**CHATGPT AS A TOOL TO SUPPORT SECONDARY SCHOOL STUDENTS IN FORMULATING RESEARCH QUESTIONS WITHIN A CRISPR-CAS BIOTECHNOLOGY RESEARCH LABORATORY CONTEXT.**	Oral		Teaching Strategies, Learning Environments and Digital Media	27.8.2026 | Room 4 | 09:30
150	Silke Sterck, Amber Gregoor, Lies Vanden Broeck, Lieve Moeyersons, Bert Oben and Marion Crauwels	**ANALYZING GAZE BEHAVIOR AND COGNITIVE PROCESSES IN EXPERTS AND NOVICES WHEN VIEWING AN ANIMATION ON PCR**	Oral		Teaching Strategies, Learning Environments and Digital Media	27.8.2026 | Room 4 | 09:45
151	Miri Levy, Pirchi Waxman, Efrat Link, Shoshi Herman, Irit Sadeh and Michal Zion	**A Self-Regulated Learning Support Model Integrating Internal and External Pedagogical Sensors to Foster Metacognitive Awareness in Open Inquiry-Based biology Learning**	Poster		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	TUE 25.8.2026
152	Tim Göddenhenrich and Benedikt Heuckmann	**From descriptive to predictive Biology - Exploration of K12-Students' Data Literacy in Biology Education**	Oral		Teaching Strategies, Learning Environments and Digital Media	27.8.2026 | Room 4 | 10:00
153	Hadeel Edrees Dabbah, Anat Yarden, Giora Alexandron and Moriah Ariely	**Automated assessment of biological explanations in Arabic: Using reflective-prompt-engineering based prompts with GenAI**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	26.8.2026 | Room 4 | 11:00
154	Marion Crauwels, Silke Sterck, Arthur Foqué, Robbe Mertens, Lieve Moeyersons and Lies Vanden Broeck	**ADDRESSING PLANT AWARENESS DISPARITY BY ENHANCING SCIENTIFIC PROCESS SKILLS AND PLANT KNOWLEDGE**	Oral		Teacher Professionalization and PCK	27.8.2026 | Room 4 | 10:15
155	Zuzana Nedvědová and Lukáš Rokos	**Teacher Self-Efficacy and the Integration of 3D Printing in Science Education**	Oral		Teaching Strategies, Learning Environments and Digital Media	26.8.2026 | Room 3 | 09:00
156	Aprillyana Dwi Utami, Andri Christodoulou and Marcus Grace	**IT'S A PARADOX – PRE-SERVICE BIOLOGY TEACHERS' PERSPECTIVES OF CULTURE-BASED SOCIO-SCIENTIFIC ISSUES**	Poster		Socioscientific Issues	WED 26.8.2026
158	Ofra Ifrah, Orit Ben Zvi Assaraf and Tom Bielik	**Structural and Content Aspects of Argumentative Writing by Fifth-Grade Students' on a Socio-Scientific Issue Concerning Human Health**	Oral		Socioscientific Issues	28.8.2026 | Room 2 | 12:00
159	Mary Kaya, Nina Christenson, Jelle Boeve-de Pauw and Niklas Gericke	**EMOTIONAL AWARENESS IN TEACHERS' ACTION COMPETENCE FOR SUSTAINABILITY AND CLIMATE CHANGE EDUCATION**	Oral		Sustainability Education (including Environmental and Health Education)	26.8.2026 | Room 5 | 09:00
160	Zeynep Güler and Burcu Güngör Cabbar	**SYSTEMS THINKING IN SUSTAINABILITY EDUCATION: CHANGE OVER TIME IN THE "SPACE JUNK" SCENARIO**	Oral		Sustainability Education (including Environmental and Health Education)	26.8.2026 | Room 5 | 09:15
161	Ismi Rakhmawati, Lucas Weinberg, Alexander Lichius, Johanna Taglieber and Suzanne Kapelari	**HOW LEARNING TOOLS SHAPE REPRESENTATION? A COMPARATIVE STUDY IN VR AND MICROSCOPE SETTINGS**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
162	Amelia Abrie, Nicola Grobler and Annie Antonites	**CO-MAMMALHUB: PRE-SERVICE TEACHER CONTRIBUTIONS TO DESIGNING A MUSEUM EXHIBIT**	Poster		Outdoor and Informal Education	TUE 25.8.2026
163	Jelle Boeve-de Pauw and Bart de Groot	**EXPLORING THE SUPPORT NEEDS OF TEACHERS AS FACILITATORS IN CITIZEN SCIENCE**	Symposia	1: Tsybulsky: Transforming Biology and Environmental Education through Citizen Science	Outdoor and Informal Education	27.8.2026 | Room 1 | 10:30

164	Johannes Poser, Daniela Fiedler, Daniel Schönle, Christoph Reich and Ute Harms	**Exploring Pre-service Biology Teachers' Assessment Competence in Evolution using a Chatbot-supported Classroom Simulation**	Symposia	4: Harms: Advancing Evolution Learning – Novel Conceptual and Methodological Approaches to Evolution Education	Conceptual change	26.8.2026 | Room 1 | 11.45
165	Gudrun Kern and Uwe Simon	**Framing Sexuality Education in Biology: A Qualitative Content Analysis of External Providers in Three Austrian Regions**	Oral		Socioscientific Issues	28.8.2026 | Room 2 | 12:15
166	Charlie Pettit, Rachel Davies and Mark Winterbottom	**Cultivating Plant Mentors: A study of Pre-Service Science Teachers' appreciation/awareness of plant science education**	Oral		Teacher Professionalization and PCK	26.8.2026 | Room 2 | 11:30
167	Pirchia Tamar Waxman, Dana Sachyani, Areen Khalaily, Ravit Golan Duncan, Shoshna Herman, Moran Shalom, Bili Friedman and Michal Zion	**Integrating Social Justice in Biology Education: Exploring Health Disparities in Diabetes**	Poster		Socioscientific Issues	WED 26.8.2026
168	Rebekka Siedler, Stefanie Hartmann, Maren Muth and Steffen Schaal	**The Gemeinsamer Fortbildungstag (GFT): A Transferable Model for Practice-Oriented Professional Development in Digitally Enhanced STEM Teaching**	Oral		Teacher Professionalization and PCK	26.8.2026 | Room 2 | 11:45
169	Marie Neumann and Benedikt Heuckmann	**Technology-Related Enacted Beliefs in Biology Education: A Methodological Exploration of the Plan-Teach-Reflect Cycle**	Poster		Teacher Professionalization and PCK	THU 27.8.2026
170	Lisa-Marie Broghammer, Melanie Basten, Laura Ferreira González, Anne Reh, René Schroeder, Daniela Sellmann-Risse, Hannah Weck and Silvia Fränkel	**Perceptions of present and future forests among students with and without special educational needs**	Oral		Conceptual change	25.8.2026 | Room 2 | 16:00
171	Tom Bewersdorf and Carolin Retzlaff-Fürst	**Promoting Artenwissen and coherence in biology teacher education – Results from the first cohort of a design-based research study**	Oral		Teacher Professionalization and PCK	26.8.2026 | Room 2 | 12:00
172	Maxi Ritter and Armin Lude	**Investigating Biodiversity Challenges using an Educational Design Research Approach**	Poster		Sustainability Education (including Environmental and Health Education)	THU 27.8.2026
173	Jorun Nylehn, Ragnhild Gya and Kjersti Lea	**Reducing misconceptions about natural selection: an intervention in upper secondary school**	Oral		Conceptual change	25.8.2026 | Room 2 | 16:15
174	Shaima Alokbe and Orit Ben-Zvi Assaraf	**Unpacking Links Between Climate Literacy and Sense of Place in a Place-Based Program for Bedouin Youth**	Oral		Sustainability Education (including Environmental and Health Education)	26.8.2026 | Room 5 | 09:30
175	Peter Lampert, Carole Chappuis, Teresa Berglund and Niklas Gericke	**MAIN: ACTION-ORIENTED SUSTAINABILITY TEACHING: STAKEHOLDER PERSPECTIVES ON OPPORTUNITIES AND CHALLENGES**	Symposia	7: Lampert: Action-Oriented Teaching for Biodiversity: Exploring Dynamics of Change	Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 3 | 11:00
176	Peter Lampert, Teresa Berglund and Niklas Gericke	**COLLABORATING WITH EXTERNAL STAKEHOLDERS: OPPORTUNITIES AND CHALLENGES FOR BIODIVERSITY ACTION**	Symposia	7: Lampert: Action-Oriented Teaching for Biodiversity: Exploring Dynamics of Change	Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 3 | 11:45
177	Moriah Ariely and Anat Yarden	**An integrated framework for evaluating students' responses to open-ended questions in biology**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	26.8.2026 | Room 4 | 11:15
178	Katja Stanič and Andreja Špernjak	**Seeing the Unseen: Augmented Reality as a Tool for Learning Biology with Live Animals**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
179	Andreja Špernjak and Katja Stanič	**Implementation and Perception of Practical Work in Lower Secondary School Biology: Teachers' Insights**	Oral		Teaching Strategies, Learning Environments and Digital Media	26.8.2026 | Room 3 | 09:15
180	Ana Birsan, Irina Petcu, Liliana Morosan and Mariana Savva	**INTEGRATION OF NEW EDUCATION IN BIOLOGY TEACHING - A NEED REFLECTED IN THE VOICE OF STUDENTS**	Poster		Students' Values, Attitudes and Decision-Making	WED 26.8.2026
181	Petra Bezeljak Cerv and Andrea Möller	**Outdoor Learning in a Protected Area: Insights from Urban Youth**	Oral		Sustainability Education (including Environmental and Health Education)	26.8.2026 | Room 5 | 09:45
182	Lucas Weinberg, Johanna Nagl, Lena Warrelmann and Suzanne Kapelari	**Soil Health Education in Austria: Topics, Challenges and Needs. A Case Study**	Poster		Sustainability Education (including Environmental and Health Education)	THU 27.8.2026
183	Paolo Lucas Sciascia, Sabine Meister and Annette Upmeier zu Belzen	**Situational Perception and Performance: Use of Prompts in Data-Based Decision-Making Tasks**	Poster		Students' Values, Attitudes and Decision-Making	WED 26.8.2026
184	Alain Sénécail, Laure Kloetzer and Julien Leuenberger	**From rules to discovery: sensory experience and relation to more-than-humans in scientific mediation at the botanical garden**	Oral		Outdoor and Informal Education	28.8.2026 | Room 3 | 11:45
185	Michael Reiss	**School vaccine education needs to take account of cultural issues**	Symposia	2: Dillon: Culturally Responsive Biology Education	Socioscientific Issues	25.8.2026 | Room 1 | 16:30
186	Dagmar Hilfert-Rüppell, Katrin Vorhölter, Andreas Plink and Manuela Harries	**Mandate or Motivation? An Exploratory Study of Students' Arguments and Conceptual Development on Hepatitis B Vaccination**	Oral		Students' Values, Attitudes and Decision-Making	26.8.2026 | Room 2 | 10:00
187	Helen Semilarski and Helin Semilarski	**BEYOND THE CLASSROOM: EXPLORING TEACHERS' ROLES IN EXTRACURRICULAR STEM PROGRAMS**	Poster		Outdoor and Informal Education	TUE 25.8.2026
188	Justus Schöller, Anna Beniermann, Matthias Ziegler and Annette Upmeier zu Belzen	**Climate Emotions in Place-Based Education: Linking Agency, Hope, Interest and Worry through Person-Situation Interaction Theory**	Oral		Sustainability Education (including Environmental and Health Education)	26.8.2026 | Room 5 | 10:00

189	Helen Semilarski and Helin Semilarski	**CONCEPTUALIZING CORE IDEAS IN SCIENCE EDUCATION: A SYSTEMATIC LITERATURE REVIEW**	Oral		Conceptual change	25.8.2026 | Room 2 | 16:30
190	Helen Semilarski and Helin Semilarski	**Navigating Current Information: An Investigation of Students' Online Information-Seeking Behavior**	Poster		Socioscientific Issues	WED 26.8.2026
191	Linda Hämmerle, Ella Guelmino and Eva Fraňková	**Climate Change Education in Austria's Teacher Education for Secondary Schools**	Poster		Sustainability Education (including Environmental and Health Education)	THU 27.8.2026
192	Veronika Winter, Linda Hämmerle and Jelle Boeve-de Pauw	**Pre-service biology teachers' beliefs, emotions and intention to implement climate change education**	Poster		Sustainability Education (including Environmental and Health Education)	THU 27.8.2026
193	Léna Somano, François Bonneton and Olivier Morin	**Problematizing development to foster the understanding of living dynamics: case of sex ontogenesis.**	Poster		Conceptual change	TUE 25.8.2026
195	Julia Rehkemper and Claas Wegner	**INVESTIGATING SELF-RELATED CONSTRUCTS IN GIRLS-ONLY GROUPS WITH BIOLOGY AND INFORMATICS CONTENT**	Poster		Socioscientific Issues	WED 26.8.2026
196	Stiina Lõhmus and Anne Laius	**Integrating Bioart into Science Teacher Education: Bridging Science, Creativity, and Sustainability**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
197	Maria Andronikou, Stella Petrou and Konstantinos Korfiatis	**Investigating Undergraduate Students' Conceptions of Circular Economy Practices**	Oral		Sustainability Education (including Environmental and Health Education)	28.8.2026 | Room 5 | 12:00
198	Raya L. Wolf, Paul W. Dierkes and Matthias W. Kleespies	**Zoos as Educational and Conservation Spaces: Perspectives from (Future) Teachers**	Poster		Outdoor and Informal Education	TUE 25.8.2026
199	Teresa Berglund and Peter Lampert	**Building action competence through action-oriented sustainability teaching in biology teacher education**	Symposia	7: Lampert: Action-Oriented Teaching for Biodiversity: Exploring Dynamics of Change	Sustainability Education (including Environmental and Health Education)	25.8.2026 | Room 3 | 11:30
200	Katharina Düsing, Maike Sauer, Cornelia Averdunk and Alexander Bergmann-Gering	**CONTENT ANALYSIS OF TEACHERS' PERSONAL AND ENACTED PCK REGARDING CORE CONCEPTS AND SYSTEMS THINKING**	Poster		Teacher Professionalization and PCK	THU 27.8.2026
201	Berrit Katharina Czinczel, Merav Siani, Moriah Ariely, Anat Yarden and Ute Harms	**Comparing Two AI-Driven Approaches To Formative Assessment In Evolution Education**	Symposia	4: Harms: Advancing Evolution Learning – Novel Conceptual and Methodological Approaches to Evolution Education	Conceptual change	26.8.2026 | Room 1 | 11:30
202	Theresa Schmidt, Alexander Georg Büssing and Dagmar Hilfert-Rüppell	**EXPLORING STUDENTS' CONCEPTIONS OF WILD BEES – INSIGHTS FROM A QUALITATIVE STUDY USING CONCEPT MAPS**	Oral		Conceptual change	25.8.2026 | Room 2 | 16:45
203	Jorge Groß and Malte Michelsen	**Rethinking Learning Progression Research: The Potential of Students' Conceptions for Understanding Non-Linear Paths of Learning**	Poster		Conceptual change	TUE 25.8.2026
204	Helin Semilarski, Helen Semilarski and Airi Alajan	**CLIMATE CHANGE AWARENESS AND ANXIETY AMONG ESTONIAN UPPER SECONDARY SCHOOL STUDENTS.**	Oral		Sustainability Education (including Environmental and Health Education)	26.8.2026 | Room 5 | 11:00
205	Noa Kedar, Moriah Ariely and Anat Yarden	**Interest-based Learning Units for the immune system: Integrating students' autonomy with curriculum requirements**	Oral		Teaching Strategies, Learning Environments and Digital Media	26.8.2026 | Room 3 | 09:30
206	Lisa Virtbauer, Lena von Kotzebue, Johanna Rehrl, Sabrina Wildner and Gabriele Gadermaier	**Students' Conceptions of (Pollen) Allergies: Exploring Ideas and Knowledge Levels in Secondary Biology Education**	Poster		Conceptual change	TUE 25.8.2026
207	Sarah Lang and Lena von Kotzebue	**Serious Games for Climate Action: Opportunities & Challenges of Digital Game-Based Learning for Biology Teachers**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
208	Richard Sannert, Verena Petermann, Janet Carlson, Jan van Driel and Moritz Krell	**Why Teacher Professional Learning Programs Can Fail: Evidence from a Professional Learning Program on Scientific Reasoning for Biology Teachers**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	26.8.2026 | Room 4 | 11:30
209	Berber de Jong, Michiel Dam and Fred J.J.M. Janssen	**Systems thinking through perspectives as a solution to low coherence in biology education**	Oral		Teaching Strategies, Learning Environments and Digital Media	26.8.2026 | Room 3 | 09:45
210	Dorian Thomsen, Dagmar Hilfert-Rüppell and Alexander Georg Büssing	**Combining Virtual Reality and Real Dissection in Biology Lessons: Effects on Cognitive Load, Interest, Disgust, and Learning Gain**	Oral		Teaching Strategies, Learning Environments and Digital Media	26.8.2026 | Room 3 | 10:00
211	Malka van Dijk, Moriah Ariely, Asaf Salman, Giora Alexandron and Anat Yarden	**STUDENTS' ENGAGEMENT WITH ARGUMENTATION IN MENDELIAN GENETICS: TWO-DIMENSIONAL AUTOMATED ASSESSMENT**	Oral		Writing, Speaking, Reading and Argumentation	26.8.2026 | Room 2 | 09:45
212	Nina Christenson	**USING THE RISK MATRIX AS A DIDACTICAL TOOL FOR TEACHING SOCIOSCIENTIFIC ISSUES IN SCIENCE EDUCATION**	Poster		Socioscientific Issues	THU 27.8.2026
213	Iva Frýzová and Natálie Čeplová	**THREE LEVELS OF CHALLENGES TEACHER EDUCATORS ENCOUNTER BY INTEGRATING EDUCATION OUTSIDE THE CLASSROOM**	Oral		Outdoor and Informal Education	28.8.2026 | Room 3 | 12:00
214	Daniel Emge and Volker Wenzel	**A model for reporting educational design research: insights from a case study on historic gardens**	Oral		Outdoor and Informal Education	28.8.2026 | Room 3 | 12:15
215	Felicitas Haupts, Jörg Großschedl, Nina Minkley, Till Schmäing and Moritz Krell	**Relevance of Task Characteristics for Preservice Biology Teachers' Modelling Processes**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	26.8.2026 | Room 4 | 11:00
217	Kim Oun and Suzanne Kapelari	**Evaluating an International Summer School on Nature-based Solutions in Science Teacher Education**	Oral		Sustainability Education (including Environmental and Health Education)	26.8.2026 | Room 5 | 11:15

218	Pål Kvello, Zhuo Li and Lars Lundheim	**A physical model of the nervous system systematically developed for increasing student motivation and understanding**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
219	Marios Sotiriadis, Katerina Michopoulou, Efstratios Valakos and Martha Georgiou	**LEARNING ABOUT SEA ANIMALS THROUGH A PLAYFUL MUSEUM EDUCATIONAL PROGRAM**	Poster		Outdoor and Informal Education	TUE 25.8.2026
220	Philipp Behrens, Anke Meisert and Jürgen Menthe	**Potential of alternative experiment protocol structuring**	Poster		Writing, Speaking, Reading and Argumentation	THU 27.8.2026
221	Anthony Benzig	**Conception and Construction of Normality and Normativity and the Role of Biology Education**	Poster		Conceptual change	TUE 25.8.2026
222	Jana Schilbert and Annette Scheersoi	**Cultivating interest in sustainable nutrition: Exploring what makes nutrition education work**	Poster		Sustainability Education (including Environmental and Health Education)	THU 27.8.2026
223	Patrícia Pessoa, J. Bernardino Lopes, Alexandre Pinto and Xana Sá-Pinto	**FOSTERING EVOLUTIONARY LITERACY AND PRO-BIODIVERSITY ATTITUDES IN ELEMENTARY STUDENTS THROUGH SOCIOSCIENTIFIC ISSUES (Symposium: Evolution Education in Early Years)**	Symposia	5: Pessoa: EVOLUTION EDUCATION IN THE EARLY YEARS	Conceptual change	25.8.2026 | Room 1 | 12:00
224	Panagiota Kotsakiozi, Panayiotis Pafilis, Efstratios Valakos and Martha Georgiou	**ANIMALS AND ANTHROPOMORPHISM IN CHILDREN'S LITERATURE: IMPLICATIONS FOR LEARNING ABOUT NATURE**	Poster		Conceptual change	TUE 25.8.2026
225	Mahdi El Tegani and Claas Wegner	**3D MODELING AND 3D PRINTING IN BIOLOGY TEACHER TRAINING - PROBLEMS AND SOLUTIONSTRATEGIES OF STUDENTS**	Oral		Teacher Professionalization and PCK	25.8.2026 | Room 4 | 16:00
226	Stina Eriksson, Karin Thörne and Niklas Gericke	**Analogy competence in science teacher education: validating and refining the ACT framework**	Oral		Teaching Strategies, Learning Environments and Digital Media	26.8.2026 | Room 3 | 10:15
227	Pia Sjöblom and Maria Svens	**Student Teachers' Perspectives on Farm Visits – Reflections and Critical Thinking**	Oral		Sustainability Education (including Environmental and Health Education)	26.8.2026 | Room 5 | 11:30
228	Stella Mehl, Lars Dietrich and Kerstin Kremer	**Fostering Biodiversity Data Literacy Using Authentic Data Sets in Biology Education**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
229	Leah Yifrach, Haya Ben Simon and Dina Tsybulsky	**Authentic Biology Education through Citizen Science: Enhancing Students' Understanding of the Nature of Science**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	26.8.2026 | Room 4 | 12:00
230	Aigi Kikkas, Regina Soobard and Miia Rannikmäe	**Designing a course to support primary school teacher students' understanding of the nature of science**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	27.8.2026 | Room 2 | 10:00
231	François Dessart, Isabel Pau-Custodio, Myriam Régent-Kloeckner, Florent Figon and Catherine Bruguière	**ANALYZING PUPILS CLIMATE CHANGE "FRESKS" PRODUCTIONS THROUGH A SYSTEMS THINKING APPROACH**	Oral		Sustainability Education (including Environmental and Health Education)	26.8.2026 | Room 5 | 11:45
232	Svea Isabel Kleinert, Justin Timm, Nora Lösing, Carolyn Erben, Jan Koschorreck, Florian Leese, Antje Ullrich, Marie-Thérése Werner and Philipp Schmiemann	**Citizen science in freshwater research for students**	Poster		Sustainability Education (including Environmental and Health Education)	THU 27.8.2026
233	Maria Ilia, Periklis Kleitou, Nikolaos Doumpas, Christina Michail, Christina Diamantoupoulou, Demetris Kletou and Konstantinos Korfiatis	**SEAMIND: Improving knowledge, pro-environmental intentions, and connectedness to the sea through Field-Lab-Classroom integration**	Poster		Sustainability Education (including Environmental and Health Education)	THU 27.8.2026
234	Li Zhuo, Maren Skjelstad Fredagsvik, Anne Berit Johnsen and Pål Kvello	**Developing model-based teaching of the nervous system for pre-service teachers through Design-based research**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
235	Kaire Jõgi and Aigi Kikkas	**Enhancing Continuity in Science Education: Aligning Early Childhood and Primary Teacher Education Programmes in Estonia**	Poster		Teacher Professionalization and PCK	THU 27.8.2026
236	Katrin Vaino, Konstantinos Korfiatis and Ana Valdmann	**Fostering systems thinking and interdisciplinary understanding of photosynthesis through design-based learning in lower secondary education**	Oral		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	27.8.2026 | Room 2 | 09:30
237	Franziska Messenböck, Sonja Kletzer, Ulrich Hobusch, Wolfgang Hinterdobler, Kerstin Kremer and Martin Scheuch	**IF THERE IS PLANT BLINDNESS – ARE WE SUFFERING FROM FUNGAL FORGETFULNESS?**	Poster		Outdoor and Informal Education	TUE 25.8.2026
238	Myrto Koutra-Iliopoulou, Apostolia Galani, Aikaterini Plakitsi and Evangelia Mavrikaki	**ENHANCING SUSTAINABILITY CONSCIOUSNESS IN SIXTH GRADE: EVIDENCE FROM AN INTEGRATED ESD AND SEL PROGRAM FROM GREECE**	Oral		Sustainability Education (including Environmental and Health Education)	26.8.2026 | Room 5 | 12:00
239	Freya Steinacher, Theresa Hofstätter and Lena von Kotzebue	**DRIVERS OF SUSTAINABLE DIETARY INTENTIONS IN ADOLESCENTS**	Poster		Sustainability Education (including Environmental and Health Education)	THU 27.8.2026
240	Ruth Amos	**Promoting collaborative biology educators' professional development for embedding climate change and sustainability in the secondary (high) school science National Curriculum in England, UK**	Oral		Teacher Professionalization and PCK	25.8.2026 | Room 4 | 16:15
241	Julia-Marie Tocco, Kai Cardinal, Heike Theyßen, Andreas Borowski and Philipp Schmiemann	**Fostering specific types of knowledge towards more academic success in the introductory phase of biology study programs**	Oral		Teaching Strategies, Learning Environments and Digital Media	26.8.2026 | Room 3 | 11:00
242	Cathérine Conradty and Franz X. Bogner	**Revealing Sustainability Citizenship: An AI-Enhanced Residual Method for Large-N Qualitative Concept Analysis**	Oral		Conceptual change	25.8.2026 | Room 2 | 17:00

243	Veronika Šilhavá and Jan Mourek	**PUBLIC INTEREST IN IDENTIFYING INVERTEBRATES IN THE MIRROR OF SOCIAL NETWORK GROUPS**	Poster		Sustainability Education (including Environmental and Health Education)	THU 27.8.2026
244	Marjanca Kos and Špela Klofutar	**FOSTERING PLANT AWARENESS IN EARLY YEARS: ACTIVITIES AND ASSESSMENT OF THEIR EFFECTIVENESS**	Poster		Outdoor and Informal Education	TUE 25.8.2026
245	Rachel Sawle and Neil Hart-Camus	**Exploring affective engagement between London's learners and the more-than-human**	Poster		Conceptual change	TUE 25.8.2026
246	Ulrich Hobusch, Petra Bezeljak Cerv, Uwe K. Simon, Benedikt Heuckmann, Gregor Torkar, Albert Zeyer, Sebastian Stuppan, Sascha Krebser, Franziska Messenboeck, Kerstin Kremer and Martin Scheuch	**EMBEDDING ONE HEALTH SOCIO-SCIENTIFIC ISSUES IN SCIENCE CLASSROOMS: CO-DESIGN AND DISCOURSE PRACTICES BETWEEN SUBJECT MATTER EXPERTS AND PRE-SERVICE TEACHERS**	Oral		Sustainability Education (including Environmental and Health Education)	28.8.2026 | Room 5 | 11:15
247	Sonja Enzinger-Mühlbacher and Nora Luschin-Ebengreuth	**Representations of Vertebrates and Invertebrates in School Biology Textbooks: A Qualitative Analysis**	Poster		Socioscientific Issues	WED 26.8.2026
248	Lucía Vázquez-Ben, Anxela Bugallo, Patrícia Pessoa, Neil Gostling, Nausica Kapsala, Deborah Kelemen, Ross Nehm, Giulia Realdon, Alexandra Moorman and Xana Sá-Pinto	**"ONE GOES EXTINCT, ONE EVOLVES": HOW 3RD GRADERS REASON ABOUT PAST AND FUTURE EVOLUTIONARY SCENARIOS (Symposium: Evolution Education in the Early Years)**	Symposia	5: Pessoa: EVOLUTION EDUCATION IN THE EARLY YEARS	Conceptual change	25.8.2026 | Room 1 | 12:15
249	Patrícia Pessoa, Deborah Kelemen, Isabell Adler, Lucía Vázquez-Ben and Penelope Papadopoulou	**MAIN: EVOLUTION EDUCATION IN THE EARLY YEARS**	Symposia	5: Pessoa: EVOLUTION EDUCATION IN THE EARLY YEARS	Conceptual change	25.8.2026 | Room 1 | 11:00
250	Leonie Johann, Magdalena Kersting and Sara Wilmes	**A Case Study on How Spatial Affordances Shape First-Grade Students' Participation in Biology Inquiry Phases within Innovative Learning Environments**	Poster		Outdoor and Informal Education	TUE 25.8.2026
251	Nuno Afonso, Adriana Ferreira and Margarida M. Marques	**EXPLORATION OF GAMES AND GAMIFICATION IN THE THEMES OF ECOSYSTEMS AND DISASTERS IN 8TH GRADE STUDENTS**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
252	Lars Dietrich, Roman Asshoff and Kerstin Kremer	**Defining Ecological Literacy as a Science Education Construct: Towards Conceptual Coherence and Operational Clarity**	Poster		Sustainability Education (including Environmental and Health Education)	THU 27.8.2026
253	Betina Lopes and Fredson Delgado	**BUILDING MICROSCOPES, BUILDING CAPACITY: REVERSE INNOVATION FOR SUSTAINABLE SCIENCE EDUCATION**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
254	Nienke Wieringa, Micha Ummels, Lidewij Van Katwijk and Caspar Geraedts	**LOWERING BARRIERS FOR STUDENT TEACHERS TO TEACH OUTDOORS**	Poster		Outdoor and Informal Education	TUE 25.8.2026
255	Myriam Régent-Kloeckner, Olivier Morin, Véronique Battie, Faïza Chellougui, Virginie Deloustal-Jorrand and Nicole Goetgheluck	**STUDENTS' CONCEPTIONS OF SCIENTIFIC EVIDENCE AND PROOF IN BIOLOGY AND MATHEMATICS HIGHER EDUCATION**	Poster		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	TUE 25.8.2026
256	Greta Sinning Quiroga, Justin Timm and Philipp Schmiemann	**Systems Thinking in the Context of Tipping Systems – Analysing Students' Concept Maps**	Poster		Scientific Thinking, Scientific Explanations, Scientific Inquiry and NOS	TUE 25.8.2026
257	Philipp Flieger, Daniel Kaiser, Roman Asshoff, Urs M. Weber and Lars Dietrich	**Exploring plant perception in landscape images by eye-tracking**	Poster		Sustainability Education (including Environmental and Health Education)	THU 27.8.2026
258	Mercédes Avignon	**Citizenship education through science: which curricular coherence for upper secondary vocational education in French-speaking Belgium?**	Poster		Socioscientific Issues	WED 26.8.2026
259	Max Mannsperger, Sonja Schaal and Steffen Schaal	**Measuring TPACK competence**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
260	Jure Mravlje, Ana Pšeničnik and Iztok Tomažič	**PRE-SERVICE BIOLOGY TEACHERS' VIEWS ON USING AI IN THEIR FUTURE PROFESSION: A PILOT STUDY**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
261	Karoline Dütemeyer and Anna Beniermann	**Overcoming avoidance in teaching Controversial Science Issues: Theoretical considerations**	Poster		Socioscientific Issues	WED 26.8.2026
262	Renata Ryplova, Tomas Mrhalek, Zbynek Vacha and Tereza Brcakova	**PLANTS IN ACTION AGAINST CLIMATE CHANGE**	Oral		Sustainability Education (including Environmental and Health Education)	28.8.2026 | Room 5 | 11:45
263	Lena Engelmann and Carolin Retzlaff-Fürst	**NATURE JOURNALING – A METHOD TO ENHANCE ARTENWISSEN IN STUDENTS**	Poster		Outdoor and Informal Education	TUE 25.8.2026
264	Kanary Allhuzaeel, Dr. Yael Shwartz and Prof. Anat Yarden	**Assessing 9th graders' comprehension of reading digital scaffolded, adapted primary literature using the SOLO-based rubric**	Oral		Teaching Strategies, Learning Environments and Digital Media	26.8.2026 | Room 3 | 11:15
265	Vanessa Freemann and Anna Beniermann	**CONCEPTUAL CHANGE VIDEOS AND TEXTS - A COMPARISON OF THE EFFECTIVENESS OF STUDENTS' CONCEPT FORMATION**	Poster		Conceptual change	TUE 25.8.2026
266	Julian Kokott and Annette Scheersoi	**Talking science over coffee – Identifying design features that foster interest and understanding of science**	Oral		Sustainability Education (including Environmental and Health Education)	28.8.2026 | Room 5 | 11:30
268	Mirela Sertić Perić and Mia Fett	**THE IMPACT OF CLASSROOM TYPE ON STUDENT MOTIVATION IN SCIENCE AND BIOLOGY EDUCATION**	Oral		Teaching Strategies, Learning Environments and Digital Media	26.8.2026 | Room 3 | 11:30

269	Karen Rysgård and Helena Bichao	**DRAW-AND-EXPLAIN TO LEARN: COLLABORATIVE PROCESSES TO LEARN ABOUT THE IMMUNE SYSTEM**	Oral		Teaching Strategies, Learning Environments and Digital Media	26.8.2026 | Room 3 | 11:45
270	Carina Mur-Spiegl and Suzanne Kapelari	**STEM in Austria: Designing effective learning materials for a new school subject.**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
271	Gisela Cebrián and Justin Dillon	**CHILD PARTICIPATION IN CLIMATE ASSEMBLIES: SUCCESS FACTORS AND INSIGHTS FROM A STUDY IN THE UK**	Oral		Sustainability Education (including Environmental and Health Education)	28.8.2026 | Room 5 | 11:00
272	Emanuel Nestler and Carolin Retzlaff-Fürst	**Game-based learning of coastal ecology: An intervention study on the impact of GBL on students' intrinsic motivation**	Poster		Teaching Strategies, Learning Environments and Digital Media	THU 27.8.2026
273	Maren Junker and Sarah Dannemann	**Educational Reconstruction of Climate-regulating Functions of Plants**	Poster		Sustainability Education (including Environmental and Health Education)	THU 27.8.2026
274	Neil Hart-Camus	**Multispecies storytelling for transformative biology education in urban schools**	Poster		Sustainability Education (including Environmental and Health Education)	THU 27.8.2026
275	Kathrin Otrel-Cass, Joey Guercio, Iris Mendel, Michael Reicho, Annika Heher, Michaela Frieß and Thomas Kosel	**CULTURALLY RESPONSIVE PEDAGOGY IN CLIMATE SCIENCE EDUCATION: EMPOWERING STUDENT VOICES**	Symposia	2: Dillon: Culturally Responsive Biology Education	Socioscientific Issues	25.8.2026 | Room 1 | 16:45

Table of contents: Book of abstracts

PRIMARY SCHOOL TEACHERS' USE OF TELEOLOGY AND ANTHROPOMORPHISM TO EXPLAIN EVOLUTION 50

SUBMISSION #: 20 50

EXPLORATION OF GAMES AND GAMIFICATION IN THE THEMES OF ECOSYSTEMS AND DISASTERS IN 8TH GRADE STUDENTS 51

SUBMISSION #: 251 51

A WINDOW INTO EPISTEMIC PRACTICES OF AN ONLINE FITNESS COMMUNITY 52

SUBMISSION #: 106 52

UNPACKING LINKS BETWEEN CLIMATE LITERACY AND SENSE OF PLACE IN A PLACE-BASED PROGRAM FOR BEDOUIN YOUTH 53

SUBMISSION #: 174 53

LEARNING ECOLOGY OUTDOORS: AUTHENTIC INQUIRY VIA CITIZEN SCIENCE 54

SUBMISSION #: 40 54

DEVELOPING BIOLOGY TEACHERS' PCK THROUGH INQUIRY-BASED MICROBIOLOGY: INSIGHTS FROM A TRAINING PROGRAMME 55

SUBMISSION #: 129 55

PROMOTING COLLABORATIVE BIOLOGY EDUCATORS' PROFESSIONAL DEVELOPMENT FOR EMBEDDING CLIMATE CHANGE AND SUSTAINABILITY IN THE SECONDARY (HIGH) SCHOOL SCIENCE NATIONAL CURRICULUM IN ENGLAND, UK 56

SUBMISSION #: 240 56

PROMOTING SUSTAINABILITY THROUGH PLANT-BASED EDUCATION: INSIGHTS FROM A NARRATIVE LITERATURE REVIEW 57

SUBMISSION #: 59 57

INVESTIGATING UNDERGRADUATE STUDENTS' CONCEPTIONS OF CIRCULAR ECONOMY PRACTICES . 58

SUBMISSION #: 197 58

AN INTEGRATED FRAMEWORK FOR EVALUATING STUDENTS' RESPONSES TO OPEN-ENDED QUESTIONS IN BIOLOGY 59

SUBMISSION #: 177 59

CREATION OF COMICS AS EVOLUTIONARY ARENAS: TRACING REASONING ACROSS MODES 60

SUBMISSION #: 128 60

CITIZENSHIP EDUCATION THROUGH SCIENCE: WHICH CURRICULAR COHERENCE FOR UPPER SECONDARY VOCATIONAL EDUCATION IN FRENCH-SPEAKING BELGIUM? 61

SUBMISSION #: 258 61

INTEGRATING MATHEMATICS INTO MIDDLE-SCHOOL BIOLOGY LESSONS: TEACHERS' PATHWAYS TO CHANGE 62

SUBMISSION #: 145 62

FOSTERING MEDIA COMPETENCE IN STEM LEARNING THROUGH THE CREATION OF EXPLANATORY VIDEOS – AN EMPRICAL COMPARISSON 63

SUBMISSION #: 120 63

POTENTIAL OF ALTERNATIVE EXPERIMENT PROTOCOL STRUCTURING 64

SUBMISSION #: 220 64

CONCEPTION AND CONSTRUCTION OF NORMALITY AND NORMATIVITY AND THE ROLE OF BIOLOGY EDUCATION 65

SUBMISSION #: 221 65

AN EMPIRICAL STUDY OF UPPER SECONDARY STUDENTS' LEARNING WITH VISUALIZATIONS OF HEXOKINASE 66

SUBMISSION #: 23 66

BUILDING ACTION COMPETENCE THROUGH ACTION-ORIENTED SUSTAINABILITY TEACHING IN BIOLOGY TEACHER EDUCATION 67

SUBMISSION #: 199 67

EXPLORATORY STUDY ON SYSTEM-RELATED KNOWLEDGE OF PRE-SERVICE BIOLOGY TEACHERS 68

SUBMISSION #: 16 68

ACTION OR REFLECTION? DEVELOPING AN INSTRUMENT TO EXAMINE ESD APPROACHES THROUGH PRE-SERVICE BIOLOGY TEACHERS' BELIEFS 69

SUBMISSION #: 116 69

PROMOTING ARTENWISSEN AND COHERENCE IN BIOLOGY TEACHER EDUCATION – RESULTS FROM THE FIRST COHORT OF A DESIGN-BASED RESEARCH STUDY 70

SUBMISSION #: 171 70

SIMULATIONS AS EPISTEMIC TOOLS: A MACHINE LEARNING-BASED ANALYSIS OF STUDENTS' UNCERTAINTY DESCRIPTIONS 71

SUBMISSION #: 96 71

ROLLING DICE IN PARSIMONY: CULTIVATING PLAYFUL TREE-THINKING IN SECONDARY BIOLOGY EDUCATION 72

SUBMISSION #: 105 72

REVOLUTIONIZING QUALITATIVE RESEARCH: AI-ASSISTED ANALYSIS OF STUDENT CONCEPTIONS ON MICROPLASTICS 73

SUBMISSION #: 25 73

CHATGPT AS A TOOL TO SUPPORT SECONDARY SCHOOL STUDENTS IN FORMULATING RESEARCH QUESTIONS WITHIN A CRISPR-CAS BIOTECHNOLOGY RESEARCH LABORATORY CONTEXT. 74

SUBMISSION #: 149 74

PERCEPTIONS OF PRESENT AND FUTURE FORESTS AMONG STUDENTS WITH AND WITHOUT SPECIAL EDUCATIONAL NEEDS 75

SUBMISSION #: 170 75

BOARD GAME TO RAISE AWARENESS OF EMERGING DISEASES SPREAD BY MOSQUITOES AND SAND FLIES IN SPAIN 76

SUBMISSION #: 107 76

REPRESENTATIONS OF EVOLUTION IN PORTUGUESE SCIENCE TEXTBOOKS 77

SUBMISSION #: 22 77

CHILD PARTICIPATION IN CLIMATE ASSEMBLIES: SUCCESS FACTORS AND INSIGHTS FROM A STUDY IN THE UK 78

SUBMISSION #: 271 78

OUTDOOR LEARNING IN A PROTECTED AREA: INSIGHTS FROM URBAN YOUTH 79

SUBMISSION #: 181 79

ACTION-ORIENTED TEACHING FOR BIODIVERSITY: EXPLORING DYNAMICS OF CHANGE 80

SUBMISSION #: 125 80

USING THE RISK MATRIX AS A DIDACTICAL TOOL FOR TEACHING SOCIOSCIENTIFIC ISSUES IN SCIENCE EDUCATION 81

SUBMISSION #: 212 81

THE WOLF : NEITHER GOOD NOR EVIL. A CASE STUDY OF A MUSEUM EXHIBITION AS A DIDACTIC DEVICE TO EXPLORE CHILDREN'S RELATIONSHIP TO ANIMALS AND THE CONSTRUCTION OF SCIENTIFIC KNOWLEDGE 82

SUBMISSION #: 38 82

"IT FEELS LIKE I'M TOUCHING THE SOIL!" STEAM GARDENS FOR A TRANSDISCIPLINARY AND TRANSFORMATIVE SCIENCE EDUCATION 83

SUBMISSION #: 53 83

REVEALING SUSTAINABILITY CITIZENSHIP: AN AI-ENHANCED RESIDUAL METHOD FOR LARGE-N QUALITATIVE CONCEPT ANALYSIS 84

SUBMISSION #: 242 84

FROM CRITICAL REASONING TO CRITICAL ACTION: A ONE HEALTH DESIGN-BASED RESEARCH 85

SUBMISSION #: 18 85

EFFECT OF DIGITAL ACTIVITY ON HIGHT SCHOOL STUDENTS' UNDERSTANDING OF CHANCE AND EVOLUTION 86

SUBMISSION #: 108 86

ADDRESSING PLANT AWARENESS DISPARITY BY ENHANCING SCIENTIFIC PROCESS SKILLS AND PLANT KNOWLEDGE 87

SUBMISSION #: 154 87

COMPARING TWO AI-DRIVEN APPROACHES TO FORMATIVE ASSESSMENT IN EVOLUTION EDUCATION 88

SUBMISSION #: 201 88

AUTOMATED ASSESSMENT OF BIOLOGICAL EXPLANATIONS IN ARABIC: USING REFLECTIVE-PROMPT-ENGINEERING BASED PROMPTS WITH GENAI 89

SUBMISSION #: 153 89

BETWEEN BELIEF AND CURRICULUM: TEACHING EVOLUTION IN A RELIGIOUSLY DIVERSE SOCIETY 90

SUBMISSION #: 137 90

TEACHING BIOLOGY: TALES FROM TWO CONTEXTS – A BOURDIEUSIAN ANALYSIS 91

SUBMISSION #: 138 91

SYSTEMS THINKING THROUGH PERSPECTIVES AS A SOLUTION TO LOW COHERENCE IN BIOLOGY EDUCATION 92

SUBMISSION #: 209 92

ASSESSMENT IN INFORMAL EVOLUTION EDUCATION: A CASE-STUDY 93

SUBMISSION #: 21 93

ANALYZING PUPILS CLIMATE CHANGE "FRESKS" PRODUCTIONS THROUGH A SYSTEMS THINKING APPROACH 94

SUBMISSION #: 231 94

DEFINING ECOLOGICAL LITERACY AS A SCIENCE EDUCATION CONSTRUCT: TOWARDS CONCEPTUAL COHERENCE AND OPERATIONAL CLARITY 95

SUBMISSION #: 252 95

MAIN: CULTURALLY RESPONSIVE BIOLOGY EDUCATION 96

SUBMISSION #: 58 96

RETHINKING ALIVENESS: HOW STUDENTS APPLY CHARACTERISTICS OF LIFE ACROSS KINGDOMS 97

SUBMISSION #: 131 97

CONTENT ANALYSIS OF TEACHERS' PERSONAL AND ENACTED PCK REGARDING CORE CONCEPTS AND SYSTEMS THINKING 98

SUBMISSION #: 200 98

OVERCOMING AVOIDANCE IN TEACHING CONTROVERSIAL SCIENCE ISSUES: THEORETICAL CONSIDERATIONS 99

SUBMISSION #: 261 99

A MODEL FOR REPORTING EDUCATIONAL DESIGN RESEARCH: INSIGHTS FROM A CASE STUDY ON HISTORIC GARDENS 100

SUBMISSION #: 214 100

NATURE JOURNALING – A METHOD TO ENHANCE ARTENWISSEN IN STUDENTS 101

SUBMISSION #: 263 101

REPRESENTATIONS OF VERTEBRATES AND INVERTEBRATES IN SCHOOL BIOLOGY TEXTBOOKS: A QUALITATIVE ANALYSIS 102

SUBMISSION #: 247 102

BIOLOGY AND ENVIRONMENTAL AWARENESS THROUGH AN ADVENTURE-BASED ANIMATED SERIES FOR YOUNG CHILDREN 103

SUBMISSION #: 47 103

ANALOGY COMPETENCE IN SCIENCE TEACHER EDUCATION: VALIDATING AND REFINING THE ACT FRAMEWORK 104

SUBMISSION #: 226 104

MINIATURE LANDSCAPES. A PROJECT OF ART & SCIENCE TO APPROACH BIODIVERSITY AT INITIAL TEACHER TRAINING 105

SUBMISSION #: 64 105

UN/EASY – SEXUALITY EDUCATION AND THE PRODUCTIVE FORCE OF FEELING UNCOMFORTABLE ... 106

SUBMISSION #: 148 106

EXPLORING PLANT PERCEPTION IN LANDSCAPE IMAGES BY EYE-TRACKING 107

SUBMISSION #: 257 107

EXPLORING THE RELATIONSHIP BETWEEN NATURE CONNECTEDNESS AND SPECIES LITERACY IN UGANDAN SECONDARY SCHOOL STUDENTS 108

SUBMISSION #: 133 108

EXPLORING PRE-SERVICE TEACHERS' CHOICES OF SUSTAINABILITY TOPIC: IMPLICATIONS FOR HOPE AND ACTION COMPETENCE 109

SUBMISSION #: 82 109

CONCEPTUAL CHANGE VIDEOS AND TEXTS - A COMPARISON OF THE EFFECTIVENESS OF STUDENTS' CONCEPT FORMATION 110

SUBMISSION #: 265 110

THREE LEVELS OF CHALLENGES TEACHER EDUCATORS ENCOUNTER BY INTEGRATING EDUCATION OUTSIDE THE CLASSROOM 111

SUBMISSION #: 213 111

PASSED THE TEST? COMPETENCE ASSESSMENT IN GERMAN BIOLOGY ABITUR TASKS 112

SUBMISSION #: 37 112

THE EXPERIMENT DESIGN TOOLBOX: A NOVEL TASK FORMAT FOR ASSESSING COMPETENCIES IN PLANNING EXPERIMENTS 113

SUBMISSION #: 43 113

HOLISTIC EDUCATION THROUGH HACKATHON: ENHANCING 21ST-CENTURY SKILLS AMONG FIFTH GRADERS - A CASE STUDY 114

SUBMISSION #: 7 114

FLEBOCOLLECT: SCHOOL CITIZEN SCIENCE TO STUDY LEISHMANIOSIS DISEASE AUTHORS AND AFFILIATION 115

SUBMISSION #: 46 115

RETHINKING BIODIVERSITY EDUCATION: EARLY INSIGHTS FROM A NATIONWIDE TEACHER TRAINING INITIATIVE 116

SUBMISSION #: 67 116

FROM DESCRIPTIVE TO PREDICTIVE BIOLOGY - EXPLORATION OF K12-STUDENTS' DATA LITERACY IN BIOLOGY EDUCATION 117

SUBMISSION #: 152 117

FUTURE TEACHERS' PERCEPTIONS ON THEIR HABILITY TO WORK ON FOOD EDUCATION IN CLASSROOM 118

SUBMISSION #: 101 118

BIOLOGY TEACHERS' CURRICULAR KNOWLEDGE. MINDING THE GAP BETWEEN OFFICIAL AND IMPLEMENTED CURRICULUM? 119

SUBMISSION #: 113 119

USING VIDEO-BASED SCIENCE OUTREACH TO SUPPORT THE TEACHING AND LEARNING OF COMPLEX EPIGENETIC CONCEPTS 120

SUBMISSION #: 146 120

SYSTEMS THINKING IN SUSTAINABILITY EDUCATION: CHANGE OVER TIME IN THE "SPACE JUNK" SCENARIO 121

SUBMISSION #: 160 121

EVALUATING AN INTERNATIONAL SUMMER SCHOOL ON NATURE-BASED SOLUTIONS IN SCIENCE TEACHER EDUCATION 122

SUBMISSION #: 217 122

EPISTEMIC EMOTIONS AS MARKERS AND MECHANISMS IN SSI LEARNING THROUGH DIGITAL CURATION 123

SUBMISSION #: 9 123

EXTINCTION OF EXPERIENCE? TO WHAT EXTENT DO SECONDARY SCHOOL STUDENTS (AGE 10-18) HAVE PERSONALLY RELEVANT NATURE EXPERIENCES? 124

SUBMISSION #: 141 124

CLIMATE CHANGE EDUCATION IN AUSTRIA'S TEACHER EDUCATION FOR SECONDARY SCHOOLS..... 125

SUBMISSION #: 191 125

MAIN: ADVANCING EVOLUTION LEARNING – NOVEL CONCEPTUAL AND METHODOLOGICAL APPROACHES TO EVOLUTION EDUCATION 126

SUBMISSION #: 89 126

MULTISPECIES STORYTELLING FOR TRANSFORMATIVE BIOLOGY EDUCATION IN URBAN SCHOOLS .. 128

SUBMISSION #: 274 128

TOGETHER FOR INSECTS? FOSTERING STUDENTS' AGENCY FOR INSECT CONSERVATION THROUGH COLLECTIVE ACTION 129

SUBMISSION #: 76 129

BLACK-BOXES RECOGNITION AS A CRUCIAL STEP IN THE PROCESS OF MECHANISTIC REASONING .. 130

SUBMISSION #: 71 130

MAIN: MECHANISTIC REASONING IN BIOLOGY: EXPLORING PROCESSES, CHALLENGES, AND EDUCATIONAL VALUE 131

SUBMISSION #: 91 131

PRE-SERVICE TEACHERS AND DIVERSITY-SENSITIVE BIOLOGY EDUCATION: PERCEPTIONS AND CHALLENGES 133

SUBMISSION #: 118 133

RELEVANCE OF TASK CHARACTERISTICS FOR PRESERVICE BIOLOGY TEACHERS' MODELLING PROCESSES 134

SUBMISSION #: 215 134

PRE-SERVICE PRIMARY SCHOOL TEACHERS PERCEPTIONS AND PREPAREDNESS TO PLAN BIOLOGY AS INQUIRY 135

SUBMISSION #: 57 135

THE EFFECT OF MECHANISTIC AND CAUSAL EXPLANATIONS ON STUDENTS' RISK PERCEPTION IN A FOODBORNE ONE HEALTH CONTEXT 136

SUBMISSION #: 86 136

MANDATE OR MOTIVATION? AN EXPLORATORY STUDY OF STUDENTS' ARGUMENTS AND CONCEPTUAL DEVELOPMENT ON HEPATITIS B VACCINATION 137

SUBMISSION #: 186 137

EMBEDDING ONE HEALTH SOCIO-SCIENTIFIC ISSUES IN SCIENCE CLASSROOMS: CO-DESIGN AND DISCOURSE PRACTICES BETWEEN SUBJECT MATTER EXPERTS AND PRE-SERVICE TEACHERS 138

SUBMISSION #: 246 138

BELIEFS ABOUT SUSTAINABLE AND HEALTHY NUTRITION AMONG YOUNG STUDENTS 140

SUBMISSION #: 109 140

STRUCTURAL AND CONTENT ASPECTS OF ARGUMENTATIVE WRITING BY FIFTH-GRADE STUDENTS' ON A SOCIO-SCIENTIFIC ISSUE CONCERNING HUMAN HEALTH 141

SUBMISSION #: 158 141

SEAMIND: IMPROVING KNOWLEDGE, PRO-ENVIRONMENTAL INTENTIONS, AND CONNECTEDNESS TO THE SEA THROUGH FIELD-LAB-CLASSROOM INTEGRATION 142

SUBMISSION #: 233 142

STUDENT SILENCE IN DIGITALLY MEDIATED SSI DISCUSSIONS 143

SUBMISSION #: 19 143

REASONS OF BIOLOGY MAJOR AND FUTURE BIOLOGY TEACHER TO STUDY BIOLOGY 144

SUBMISSION #: 31 144

IDENTIFYING PRECONCEPTIONS IN DEVELOPMENTAL ASPECTS OF EVOLUTION 145

SUBMISSION #: 92 145

ENHANCING CONTINUITY IN SCIENCE EDUCATION: ALIGNING EARLY CHILDHOOD AND PRIMARY TEACHER EDUCATION PROGRAMMES IN ESTONIA 146

SUBMISSION #: 235 146

A CASE STUDY ON HOW SPATIAL AFFORDANCES SHAPE FIRST-GRADE STUDENTS' PARTICIPATION IN BIOLOGY INQUIRY PHASES WITHIN INNOVATIVE LEARNING ENVIRONMENTS 148

SUBMISSION #: 250 148

EDUCATIONAL RECONSTRUCTION OF CLIMATE-REGULATING FUNCTIONS OF PLANTS 149

SUBMISSION #: 273 149

DESIGNING FOR EXPANSIVE LEARNING: HOW FLEXIBLE CITIZEN SCIENCE CURRICULA CAN EMPOWER STUDENTS' AGENCY 150

SUBMISSION #: 72 150

EMOTIONAL AWARENESS IN TEACHERS' ACTION COMPETENCE FOR SUSTAINABILITY AND CLIMATE CHANGE EDUCATION 151

SUBMISSION #: 159 151

INTEREST-BASED LEARNING UNITS FOR THE IMMUNE SYSTEM: INTEGRATING STUDENTS' AUTONOMY WITH CURRICULUM REQUIREMENTS 152

SUBMISSION #: 205 152

BIG IDEAS IN ELEMENTARY SCHOOL: A NEW CURRICULUM FOR LEARNING ABOUT EVOLUTION BY NATURAL SELECTION IN THIRD GRADE (SYMPOSIUM: EVOLUTION EDUCATION IN EARLY YEARS) 153

SUBMISSION #: 66 153

FRAMING SEXUALITY EDUCATION IN BIOLOGY: A QUALITATIVE CONTENT ANALYSIS OF EXTERNAL PROVIDERS IN THREE AUSTRIAN REGIONS 154

SUBMISSION #: 165 154

DESIGNING A COURSE TO SUPPORT PRIMARY SCHOOL TEACHER STUDENTS' UNDERSTANDING OF THE NATURE OF SCIENCE 155

SUBMISSION #: 230 155

MEASURING STUDENTS' PERCEIVED COMPETENCE DURING EXPERIMENTATION 156

SUBMISSION #: 127 156

CITIZEN SCIENCE IN FRESHWATER RESEARCH FOR STUDENTS 157

SUBMISSION #: 232 157

TALKING SCIENCE OVER COFFEE – IDENTIFYING DESIGN FEATURES THAT FOSTER INTEREST AND UNDERSTANDING OF SCIENCE 158

SUBMISSION #: 266 158

AI-ENHANCED E-LEARNING IN WARTIME: ASSESSING THE DIDACTIC FEASIBILITY OF A GAMIFIED BIOCHEMISTRY COURSE IN UKRAINIAN UNIVERSITIES 159

SUBMISSION #: 55 159

REFLECTION, PCK, AND PROFESSIONAL VISION: INSIGHTS FROM PRE-SERVICE BIOLOGY TEACHERS' PRACTICE 160

SUBMISSION #: 68 160

FOSTERING PLANT AWARENESS IN EARLY YEARS: ACTIVITIES AND ASSESSMENT OF THEIR EFFECTIVENESS 161

SUBMISSION #: 244 161

ANIMALS AND ANTHROPOMORPHISM IN CHILDREN'S LITERATURE: IMPLICATIONS FOR LEARNING ABOUT NATURE 162

SUBMISSION #: 224 162

ENHANCING SUSTAINABILITY CONSCIOUSNESS IN SIXTH GRADE: EVIDENCE FROM AN INTEGRATED ESD AND SEL PROGRAM FROM GREECE 163

SUBMISSION #: 238 163

AI-POWERED GENERATING MCQS FOR ASSESSMENTS IN BIOLOGY 164

SUBMISSION #: 5 164

A PHYSICAL MODEL OF THE NERVOUS SYSTEM SYSTEMATICALLY DEVELOPED FOR INCREASING STUDENT MOTIVATION AND UNDERSTANDING 165

SUBMISSION #: 218 165

ASSESSING SCIENCE TEACHER PREPAREDNESS FOR SUSTAINABILITY AND ENERGY EDUCATION: DEVELOPMENT OF A READINESS INDEX 167

SUBMISSION #: 28 167

MAIN: ACTION-ORIENTED SUSTAINABILITY TEACHING: STAKEHOLDER PERSPECTIVES ON OPPORTUNITIES AND CHALLENGES 168

SUBMISSION #: 175 168

COLLABORATING WITH EXTERNAL STAKEHOLDERS: OPPORTUNITIES AND CHALLENGES FOR BIODIVERSITY ACTION 170

SUBMISSION #: 176 170

SERIOUS GAMES FOR CLIMATE ACTION: OPPORTUNITIES & CHALLENGES OF DIGITAL GAME-BASED LEARNING FOR BIOLOGY TEACHERS 171

SUBMISSION #: 207 171

EVALUATING THE IMPACT OF E3D ECO-LABELING ON PRIMARY SCHOOL STUDENTS' ACTION COMPETENCE FOR SUSTAINABILITY: A PILOT STUDY 172

SUBMISSION #: 11 172

A SELF-REGULATED LEARNING SUPPORT MODEL INTEGRATING INTERNAL AND EXTERNAL PEDAGOGICAL SENSORS TO FOSTER METACOGNITIVE AWARENESS IN OPEN INQUIRY-BASED BIOLOGY LEARNING 173

SUBMISSION #: 151 173

"THEY FELT SEEN IN THAT MOMENT": EXPLORING BIOLOGY TEACHERS' UNDERSTANDING OF THIRD SPACE PEDAGOGY 174

SUBMISSION #: 32 174

INTEGRATING BIOART INTO SCIENCE TEACHER EDUCATION: BRIDGING SCIENCE, CREATIVITY, AND SUSTAINABILITY 175

SUBMISSION #: 196 175

WHY DON'T THEY GET IT? IDENTIFYING AND EXPLAINING SLOW SPOTS IN EXPLANATION PROGRESS 176

SUBMISSION #: 48 176

CAUSAL PROBLEMS IN EVERYDAY LAY REASONING: CONNECTING GOALS OF USE WITH INFORMATION TYPES 177

SUBMISSION #: 87 177

BUILDING MICROSCOPES, BUILDING CAPACITY: REVERSE INNOVATION FOR SUSTAINABLE SCIENCE EDUCATION 178

SUBMISSION #: 253 178

UPPER SECONDARY STUDENTS' VIEWS OF SEXUALITY EDUCATION 179

SUBMISSION #: 56 179

TEACHING STRATEGIES AND THEORIES IN SCHOOL-BASED SLEEP EDUCATION PROGRAMMES – A LITERATURE REVIEW 180

SUBMISSION #: 147 180

TEACHING METHODS USED IN THE UNIVERSITY BOTANIC GARDENS LJUBLJANA 181

SUBMISSION #: 62 181

MEASURING TPACK COMPETENCE 182

SUBMISSION #: 259 182

THE ROLE OF PERSONAL ENGAGEMENT IN SCIENTISTS' DIDACTIC TRANSPOSITION OF BIOLOGICAL KNOWLEDGE 183

SUBMISSION #: 84 183

UNDERSTANDING TEACHER TRAINEES' CRITICAL CHOICES IN APPLYING INQUIRY-BASED LEARNING ACTIVITIES IN BIOLOGY CLASSROOMS 184

SUBMISSION #: 83 184

CRITICAL THINKING CRITERIA FOR MANAGING MEDIA INFORMATION ON ANTIBIOTIC RESISTANCE .. 185

SUBMISSION #: 27 185

FOSTERING BIODIVERSITY DATA LITERACY USING AUTHENTIC DATA SETS IN BIOLOGY EDUCATION . 186

SUBMISSION #: 228 186

MAPPING HOW ESD COMPETENCES ARE ASSESSED IN SECONDARY EDUCATION: IMPLICATIONS FOR TEACHERS 187

SUBMISSION #: 115 187

IF THERE IS PLANT BLINDNESS – ARE WE SUFFERING FROM FUNGAL FORGETFULNESS? 188

SUBMISSION #: 237 188

KNOWLEDGE ABOUT AND ATTITUDE TOWARDS BEES IN GRADES 4 AND 8 OF PRIMARY SCHOOL 189

SUBMISSION #: 123 189

NATURE IN SWEDISH LOWER SECONDARY BIOLOGY: WESTERN HEGEMONY OR PLURIVERSALITY? .. 190

SUBMISSION #: 69 190

SCIENCE COMICS AS INTERACTIVE DIDACTIC RESOURCES: IMPACTS ON NON-FORMAL SCIENCE EDUCATION CONTEXT 191

SUBMISSION #: 144 191

PRE-SERVICE BIOLOGY TEACHERS' VIEWS ON USING AI IN THEIR FUTURE PROFESSION: A PILOT STUDY 192

SUBMISSION #: 260 192

STEM IN AUSTRIA: DESIGNING EFFECTIVE LEARNING MATERIALS FOR A NEW SCHOOL SUBJECT. 193

SUBMISSION #: 270 193

FRAMING ACTION COMPETENCE FOR CLIMATE CHANGE: INSIGHTS FROM ESD AND APPLICATIONS IN BIOLOGY EDUCATION 194

SUBMISSION #: 94 194

TEACHER SELF-EFFICACY AND THE INTEGRATION OF 3D PRINTING IN SCIENCE EDUCATION 195

SUBMISSION #: 155 195

GAME-BASED LEARNING OF COASTAL ECOLOGY: AN INTERVENTION STUDY ON THE IMPACT OF GBL ON STUDENTS' INTRINSIC MOTIVATION 196

SUBMISSION #: 272 196

TECHNOLOGY-RELATED ENACTED BELIEFS IN BIOLOGY EDUCATION: A METHODOLOGICAL EXPLORATION OF THE PLAN-TEACH-REFLECT CYCLE 197

SUBMISSION #: 169 197

TRANSFORMING CLIMATE REPRESENTATIONS: EXPERIENTIAL TOOLS IN AGRICULTURAL EDUCATION 198

SUBMISSION #: 61 198

REDUCING MISCONCEPTIONS ABOUT NATURAL SELECTION: AN INTERVENTION IN UPPER SECONDARY SCHOOL 199

SUBMISSION #: 173 199

ADDRESSING BIOMASS MISCONCEPTIONS WITH SYSTEMS THINKING MODELS IN PHOTOSYNTHESIS 200

SUBMISSION #: 99 200

A THEORY OF PLANNED BEHAVIOR APPROACH TO FOSTERING PRE-SERVICE BIOLOGY TEACHERS' USE OF DIGITAL INCREMENTAL SCAFFOLDS 201

SUBMISSION #: 81 201

DEVELOPMENT AND VALIDATION OF A NUTRITION QUESTIONNAIRE BASED ON KAP AND HBM 202

SUBMISSION #: 74 202

ENHANCING PHOTOSYNTHESIS LITERACY IN SECONDARY EDUCATION: EVALUATING A FRAMEWORK-BASED TEACHING DESIGN 203

SUBMISSION #: 65 203

CULTURALLY RESPONSIVE PEDAGOGY IN CLIMATE SCIENCE EDUCATION: EMPOWERING STUDENT VOICES 204

SUBMISSION #: 275 204

MAIN: LEARNING TO CARE: TRANSFORMING BIOLOGY EDUCATION THROUGH BIODIVERSITY AWARENESS 205

SUBMISSION #: 130 205

TEACHING AND LEARNING EVOLUTION IN EARLY CHILDHOOD EDUCATION: A MAPPING LITERATURE REVIEW 207

SUBMISSION #: 60 207

DRAWINGS OF MICROORGANISMS BY PRESCHOOL STUDENTS: DESIGN OF AN ANALYSIS RUBRIC AND COMPARISON BETWEEN HUMAN AND ARTIFICIAL INTELLIGENCE EVALUATIONS 208

SUBMISSION #: 52 208

EXPLORING THE SUPPORT NEEDS OF TEACHERS AS FACILITATORS IN CITIZEN SCIENCE 209

SUBMISSION #: 163 209

LEARNING FOR SUSTAINABILITY WITH DIGITAL STRUCTURED INQUIRY 210

SUBMISSION #: 134 210

THE IMPACT OF CLASSROOM TYPE ON STUDENT MOTIVATION IN SCIENCE AND BIOLOGY EDUCATION 211

SUBMISSION #: 268 211

BIODIVERCITY-ISLAND HOPPING – CHANGING ATTITUDES TOWARDS PLANTS AND INSECTS THROUGH ACTION 212

SUBMISSION #: 132 212

MAIN: EVOLUTION EDUCATION IN THE EARLY YEARS 213

SUBMISSION #: 249 213

FOSTERING EVOLUTIONARY LITERACY AND PRO-BIODIVERSITY ATTITUDES IN ELEMENTARY STUDENTS THROUGH SOCIOSCIENTIFIC ISSUES (SYMPOSIUM: EVOLUTION EDUCATION IN EARLY YEARS) 215

SUBMISSION #: 223 215

CULTIVATING PLANT MENTORS: A STUDY OF PRE-SERVICE SCIENCE TEACHERS' APPRECIATION/AWARENESS OF PLANT SCIENCE EDUCATION 216

SUBMISSION #: 166 216

EXPLORING PRE-SERVICE BIOLOGY TEACHERS' ASSESSMENT COMPETENCE IN EVOLUTION USING A CHATBOT-SUPPORTED CLASSROOM SIMULATION 217

SUBMISSION #: 164 217

SYSTEMS THINKING IN THE CONTEXT OF TIPPING SYSTEMS – ANALYSING STUDENTS' CONCEPT MAPS 218

SUBMISSION #: 256 218

A SENSE OF WONDER TOWARDS PLANT LIFE 219

SUBMISSION #: 140 219

HOW LEARNING TOOLS SHAPE REPRESENTATION? A COMPARATIVE STUDY IN VR AND MICROSCOPE SETTINGS 220

SUBMISSION #: 161 220

SPACES OF EFFICACY: A MIXED-METHODS STUDY ON PERCEIVED BEHAVIORAL CONTROL IN THE CONTEXT OF AN ENVIRONMENTAL EDUCATION WORKSHOP 221

SUBMISSION #: 119 221

STUDENTS' CONCEPTIONS OF SCIENTIFIC EVIDENCE AND PROOF IN BIOLOGY AND MATHEMATICS HIGHER EDUCATION 222

SUBMISSION #: 255 222

INVESTIGATING SELF-RELATED CONSTRUCTS IN GIRLS-ONLY GROUPS WITH BIOLOGY AND INFORMATICS CONTENT 223

SUBMISSION #: 195 223

SCHOOL VACCINE EDUCATION NEEDS TO TAKE ACCOUNT OF CULTURAL ISSUES 224

SUBMISSION #: 185 224

INVESTIGATING BIODIVERSITY CHALLENGES USING AN EDUCATIONAL DESIGN RESEARCH APPROACH 225

SUBMISSION #: 172 225

WHERE CAN WE FOSTER STEM CAREER ASPIRATIONS? EMPIRICALLY COMPARING AN IN-SCHOOL AND OUT-OF-SCHOOL LEARNING PLACE 226

SUBMISSION #: 114 226

DEVELOPING CAPABILITIES FOR CRITICAL EXAMINATION OF BIOLOGY-RELATED ISSUES IN THE MEDIA. A DESIGN-BASED STUDY IN UPPER SECONDARY SCHOOL 227

SUBMISSION #: 17 227

EXPLORING PRIMARY PUPILS' UNDERSTANDING OF THE IMMUNE SYSTEM USING DRAWING TASKS AND SEMI-STRUCTURED INTERVIEWS 228

SUBMISSION #: 54 228

PLANTS IN ACTION AGAINST CLIMATE CHANGE 229

SUBMISSION #: 262 229

DRAW-AND-EXPLAIN TO LEARN: COLLABORATIVE PROCESSES TO LEARN ABOUT THE IMMUNE SYSTEM 230

SUBMISSION #: 269 230

EVALUATING A TEACHER TRAINING MODULE ON ENERGY AND SUSTAINABLE DEVELOPMENT: A MIXED-METHODS STUDY OF COMPETENCE DEVELOPMENT IN EDUCATION FOR SUSTAINABLE DEVELOPMENT 232

SUBMISSION #: 34 232

CULTIVATING CLIMATE ACTIVIST TEACHERS: INSIGHTS FROM A COURSE ON ENVIRONMENTAL EDUCATION AND ACTION- A CASE STUDY 233

SUBMISSION #: 8 233

WHY TEACHER PROFESSIONAL LEARNING PROGRAMS CAN FAIL: EVIDENCE FROM A PROFESSIONAL LEARNING PROGRAM ON SCIENTIFIC REASONING FOR BIOLOGY TEACHERS 234

SUBMISSION #: 208 234

SUPPORTING COPING STRATEGIES THROUGH EMOTION-SENSITIVE CLIMATE CHANGE EDUCATION 235

SUBMISSION #: 75 235

EXPLORING AFFECTIVE ENGAGEMENT BETWEEN LONDON'S LEARNERS AND THE MORE-THAN-HUMAN 236

SUBMISSION #: 245 236

EXPLORING THE QUALITIES OF NATURE EXPERIENCES ACROSS URBAN AND RURAL LEARNING ENVIRONMENTS 238

SUBMISSION #: 112 238

CULTIVATING INTEREST IN SUSTAINABLE NUTRITION: EXPLORING WHAT MAKES NUTRITION EDUCATION WORK 239

SUBMISSION #: 222 239

PROFESSIONAL DEVELOPMENT FOR INQUIRY-BASED LEARNING: WHAT CONTENT MATTERS TO PRE-SERVICE AND IN-SERVICE BIOLOGY TEACHERS? 240

SUBMISSION #: 39 240

EXPLORING STUDENTS' CONCEPTIONS OF WILD BEES – INSIGHTS FROM A QUALITATIVE STUDY USING CONCEPT MAPS 241

SUBMISSION #: 202 241

BRIDGING THE DIMENSIONAL GAP: COMPARING 2D AND SIMPLIFIED 3D MODELS FOR TEACHING TRANSLATION - A DESIGN-BASED RESEARCH PROJECT 242

SUBMISSION #: 111 242

CLIMATE EMOTIONS IN PLACE-BASED EDUCATION: LINKING AGENCY, HOPE, INTEREST AND WORRY THROUGH PERSON-SITUATION INTERACTION THEORY 243

SUBMISSION #: 188 243

SITUATIONAL PERCEPTION AND PERFORMANCE: USE OF PROMPTS IN DATA-BASED DECISION-MAKING TASKS 244

SUBMISSION #: 183 244

FROM RULES TO DISCOVERY: SENSORY EXPERIENCE AND RELATION TO MORE-THAN-HUMANS IN SCIENTIFIC MEDIATION AT THE BOTANICAL GARDEN 245

SUBMISSION #: 184 245

BRINGING PLANKTON RESEARCH INTO THE CLASSROOM: AN ESSENTIAL STEP TOWARD A CLIMATE LITERATE SOCIETY 246

SUBMISSION #: 36 246

MECHANISTIC REASONING AS A LENS ON CHILDREN'S PLANT AWARENESS 247

SUBMISSION #: 50 247

USING MACHINE LEARNING TO ASSESS STUDENTS' RESPONSES TO EVOLUTION SCIENTIFIC EXPLANATION QUESTIONS 248

SUBMISSION #: 95 248

THE GEMEINSAMER FORTBILDUNGSTAG (GFT): A TRANSFERABLE MODEL FOR PRACTICE-ORIENTED PROFESSIONAL DEVELOPMENT IN DIGITALLY ENHANCED STEM TEACHING 249

SUBMISSION #: 168 249

PUBLIC INTEREST IN IDENTIFYING INVERTEBRATES IN THE MIRROR OF SOCIAL NETWORK GROUPS . 250

SUBMISSION #: 243 250

CONCEPTUALIZING THE EDUCATIONAL VALUE OF CITIZEN SCIENCE FOR FOSTERING SCIENTIFIC AND STATISTICAL REASONING AND NOS UNDERSTANDING 251

SUBMISSION #: 45 251

STUDENT TEACHERS' PERSPECTIVES ON FARM VISITS – REFLECTIONS AND CRITICAL THINKING 252

SUBMISSION #: 227 252

PROBLEMATIZING DEVELOPMENT TO FOSTER THE UNDERSTANDING OF LIVING DYNAMICS: CASE OF SEX ONTOGENESIS. 253

SUBMISSION #: 193 253

FOSTERING AND LINKING REFLECTION AND RESEARCH COMPETENCE AMONG PRESERVICE BIOLOGY TEACHERS 254

SUBMISSION #: 63 254

LEARNING ABOUT SEA ANIMALS THROUGH A PLAYFUL MUSEUM EDUCATIONAL PROGRAM 255

SUBMISSION #: 219 255

BIOLOGY TEACHERS AS CHANGE AGENTS - POTENTIALS FOR TRANSFER OF DIGITALLY-SUPPORTED SCIENTIFIC INQUIRY 256

SUBMISSION #: 85 256

IMPLEMENTATION AND PERCEPTION OF PRACTICAL WORK IN LOWER SECONDARY SCHOOL BIOLOGY: TEACHERS' INSIGHTS 257

SUBMISSION #: 179 257

SEEING THE UNSEEN: AUGMENTED REALITY AS A TOOL FOR LEARNING BIOLOGY WITH LIVE ANIMALS 258

SUBMISSION #: 178 258

DRIVERS OF SUSTAINABLE DIETARY INTENTIONS IN ADOLESCENTS 259

SUBMISSION #: 239 259

ANALYZING GAZE BEHAVIOR AND COGNITIVE PROCESSES IN EXPERTS AND NOVICES WHEN VIEWING AN ANIMATION ON PCR 260

SUBMISSION #: 150 260

HOW DO PRE-SERVICE BIOLOGY TEACHERS CONSTRUE "ADAPTATION"? ELICITING PERSONAL CONSTRUCTS USING THE REPERTORY GRID METHOD 261

SUBMISSION #: 139 261

NAVIGATING CURRENT INFORMATION: AN INVESTIGATION OF STUDENTS' ONLINE INFORMATION-SEEKING BEHAVIOR 262

SUBMISSION #: 190 262

A ROLE FOR INDIVIDUAL-LEVEL MECHANISMS IN DEVELOPING INTEGRATED EVOLUTIONARY EXPLANATIONS 263

SUBMISSION #: 90 263

3D MODELING AND 3D PRINTING IN BIOLOGY TEACHER TRAINING - PROBLEMS AND SOLUTIONSTRATEGIES OF STUDENTS 264

SUBMISSION #: 225 264

COMBINING VIRTUAL REALITY AND REAL DISSECTION IN BIOLOGY LESSONS: EFFECTS ON COGNITIVE LOAD, INTEREST, DISGUST, AND LEARNING GAIN 265

SUBMISSION #: 210 265

FOSTERING SPECIFIC TYPES OF KNOWLEDGE TOWARDS MORE ACADEMIC SUCCESS IN THE INTRODUCTORY PHASE OF BIOLOGY STUDY PROGRAMS 266

SUBMISSION #: 241 266

TEACHER PROFESSIONALIZATION PROGRAMME ON PLANT SPECIES CONSERVATION AT THE UNIVERSITY BOTANIC GARDENS LJUBLJANA 267

SUBMISSION #: 73 267

BEYOND THE CLASSROOM: BIODIVERSITY IN ACTION 268

SUBMISSION #: 117 268

TEACHERS AS AGENTS OF CHANGE: MOTIVATION AND AGENCY FOR TEACHING CLIMATE CHANGE .. 269

SUBMISSION #: 24 269

EXPLORING HOW THE CONCEPT "ADAPTATION" IS DEFINED IN SCIENTIFIC ARTICLES USING TEXT MINING 270

SUBMISSION #: 77 270

HOW IS "ANCESTRY" CONCEPTUALIZED IN THE JOURNAL PLOS GENETICS? 271

SUBMISSION #: 78 271

MAIN: TRANSFORMING BIOLOGY AND ENVIRONMENTAL EDUCATION THROUGH CITIZEN SCIENCE .. 272

SUBMISSION #: 102 272

PROMOTING SYSTEMS THINKING: THE EFFECTS OF INSTRUCTIONAL GUIDANCE IN THE COMBINED USE OF DIGITAL SYSTEM MODELS 274

SUBMISSION #: 33 274

DEVELOPING PRESERVICE TEACHERS´ SYSTEMS THINKING BY ELABORATING NETWORKS OF IDEAS 275

SUBMISSION #: 12 275

IT'S A PARADOX – PRE-SERVICE BIOLOGY TEACHERS' PERSPECTIVES OF CULTURE-BASED SOCIO-SCIENTIFIC ISSUES 276

SUBMISSION #: 156 276

FOSTERING SYSTEMS THINKING AND INTERDISCIPLINARY UNDERSTANDING OF PHOTOSYNTHESIS THROUGH DESIGN-BASED LEARNING IN LOWER SECONDARY EDUCATION 277

SUBMISSION #: 236 277

MOTIVATION, PREPARATION, AND LEARNING STRATEGIES IN THE ESTONIAN BIOLOGY OLYMPIAD: A COMPARATIVE STUDY BETWEEN BASIC AND UPPER SECONDARY STUDENTS 278

SUBMISSION #: 14 278

STUDENTS' ENGAGEMENT WITH ARGUMENTATION IN MENDELIAN GENETICS: TWO-DIMENSIONAL AUTOMATED ASSESSMENT 279

SUBMISSION #: 211 279

COLLECTIVE OVER INDIVIDUAL? PATTERNS OF ACTION COMPETENCE DEVELOPMENT THROUGH A CLIMATHON 280

SUBMISSION #: 126 280

STUDENTS' SATISFACTION WITH A WASTE-MANAGEMENT EVENT: AN EVALUATION OF THE "WASTE COMPETITION" 281

SUBMISSION #: 122 281

ONE GOES EXTINCT, ONE EVOLVES: HOW 3RD GRADERS REASON ABOUT PAST AND FUTURE EVOLUTIONARY SCENARIOS (SYMPOSIUM: EVOLUTION EDUCATION IN THE EARLY YEARS) 282

SUBMISSION #: 248 282

ANALYZING BIOLOGY TEXTBOOK QUESTION DESIGN AND STUDENT LEARNING OUTCOMES IN KOSOVO CLASSROOMS 283

SUBMISSION #: 93 283

ENHANCING MOTIVATION IN BIOLOGY AND PRE-SERVICE TEACHERS' PROFESSIONAL IDENTITIES THROUGH AESTHETIC APPROACHES 284

SUBMISSION #: 100 284

STUDENTS' CONCEPTIONS OF (POLLEN) ALLERGIES: EXPLORING IDEAS AND KNOWLEDGE LEVELS IN SECONDARY BIOLOGY EDUCATION 285

SUBMISSION #: 206 285

STUDENTS' MEANING-MAKING IN ECOLOGY EDUCATION 286

SUBMISSION #: 41 286

SHIFTING BETWEEN MECHANISTIC AND NARRATIVE REASONING – TOWARDS A DYNAMIC VIEW OF COGNITIVE CONSTRUALS? 287

SUBMISSION #: 88 287

INTEGRATING SOCIAL JUSTICE IN BIOLOGY EDUCATION: EXPLORING HEALTH DISPARITIES IN DIABETES 288

SUBMISSION #: 167 288

SOIL HEALTH EDUCATION IN AUSTRIA: TOPICS, CHALLENGES AND NEEDS. A CASE STUDY 289

SUBMISSION #: 182 289

BIODIVERSITY EDUCATION AND SPECIES KNOWLEDGE – GERMAN PRIMARY SCHOOL CHILDREN'S CONCEPTIONS ABOUT BIRDS 290

SUBMISSION #: 35 290

PROMOTING NATURE CONNECTEDNESS THROUGH GUIDED SELF-REFLECTION ON NATURE-BASED ACTIVITIES AMONG SECONDARY SCHOOL BIOLOGY STUDENTS 291

SUBMISSION #: 136 291

LOWERING BARRIERS FOR STUDENT TEACHERS TO TEACH OUTDOORS 292

SUBMISSION #: 254 292

CHANGE IN PRESERVICE SCIENCE TEACHERS' TECHNOLOGY-RELATED BELIEFS: THE ROLE OF DOMAIN-SPECIFICITY 293

SUBMISSION #: 80 293

PRE-SERVICE BIOLOGY TEACHERS' BELIEFS, EMOTIONS AND INTENTION TO IMPLEMENT CLIMATE CHANGE EDUCATION 294

SUBMISSION #: 192 294

ZOOS AS EDUCATIONAL AND CONSERVATION SPACES: PERSPECTIVES FROM (FUTURE) TEACHERS . 295

SUBMISSION #: 198 295

VALID ASSESSMENT OF THE UNDERSTANDING OF NATURE OF SCIENCE - A SYSTEMATIC LITERATURE REVIEW 296

SUBMISSION #: 79 296

DESIGNING INQUIRY-BASED TEACHING TO ENHANCE STUDENTS' SCIENTIFIC CREATIVITY: A CASE STUDY WITH A CHINESE BIOLOGY TEACHER 297

SUBMISSION #: 26 297

AUTHENTIC BIOLOGY EDUCATION THROUGH CITIZEN SCIENCE: ENHANCING STUDENTS' UNDERSTANDING OF THE NATURE OF SCIENCE 298

SUBMISSION #: 229 298

TELL ME MORE ABOUT PLANTS! 299

SUBMISSION #: 70 299

UNDERSTANDING INTERDISCIPLINARY TOPICS IN SCIENCE 300

SUBMISSION #: 42 300

DEVELOPING MODEL-BASED TEACHING OF THE NERVOUS SYSTEM FOR PRE-SERVICE TEACHERS THROUGH DESIGN-BASED RESEARCH 301

SUBMISSION #: 234 301

INVESTIGATING TEACHERS' PROFESSIONAL DEVELOPMENT PROGRAMS ON CLIMATE CHANGE EDUCATION 302

SUBMISSION #: 49 302

Primary school teachers' use of teleology and anthropomorphism to explain evolution

Isabell K. Adler and Sebastian Tempelmann

| Symposia | 5: Pessoa: EVOLUTION EDUCATION IN THE EARLY YEARS

Keywords: *Explanations, Evolution, Teacher Education, Primary Education*

Submission #: 20

Intuitive explanations, like anthropomorphism and teleology, are central to human thinking and shape how individuals understand scientific phenomena. When explaining scientific concepts, such as evolution, teachers often draw on those intuitive thought patterns. Yet it remains unclear whether teachers specifically rely on intuitive explanations to explain evolution because biological phenomena more readily elicit anthropomorphic and teleological thinking, or whether they use them as general pedagogical strategies across disciplines. The presented study examines the context-dependent use of anthropomorphism and teleology by 60 experienced primary school teachers and their reasoning for employing them. Participants received scientific texts on biological and non-biological phenomena, then wrote explanations for a first-grade student and for an expert and took part in guided interviews afterwards. The written explanations and interviews were analyzed using qualitative content analysis. The analysis of preliminary data indicates that anthropomorphic and teleological explanations occur more frequently in evolutionary than in physical or chemical contexts. In turn, teachers generally rejected intentional language in science but considered it more acceptable for inanimate phenomena. In general, the teachers used intuitive explanations more often in the learner than in the expert condition. The findings suggest that teachers adjust their use of intuitive explanations according to disciplinary context and purpose. Data collection will be completed prior to the ERIDOB conference, at which the full analysis will be presented. (This contribution is part of the symposium Evolution Education in Early Years)

Exploration of games and gamification in the themes of ecosystems and disasters in 8th grade students

Nuno Afonso, Adriana Ferreira and Margarida M. Marques

| Poster |

Keywords: *Game-Based Learning, Gamification, Science-Technology-Society-Environment (Stse), Natural Sciences Education, Curricular Learning, Ecosystems, Catastrophes, Action Research*

Submission #: 251

Contemporary education faces the challenge of fostering critical thinking (CT) and higher-order cognitive skills to prepare autonomous citizens capable of addressing complex socio-environmental issues. In 8th-grade Natural Sciences, curricular themes such as “Ecosystem management and sustainable development”, “Disasters and ecosystem balance”, and “Protection of ecosystems” require not only biological knowledge but also analytical and evidence-based decision-making abilities. This study aimed to evaluate the contribution of a didactic sequence, grounded in the Science-Technology-Society-Environment (STSE) framework and integrating Game-Based Learning (GBL) and gamification, to mobilise Curricular Learning (CL) related to these themes. The research followed a socio-critical paradigm within the first cycle of an action-research project, employing mixed methods. Two team-based games, “Catastrophes” and “Science Market”, were implemented to promote systematic inquiry and student engagement. Data collection included reflection worksheets, mental maps, game passports, and questionnaires. Content analysis and descriptive statistics were applied to assess conceptual learning and performance indicators. Findings revealed a positive impact on CL mobilisation. Students demonstrated the ability to transfer game concepts to real-world contexts, distinguish natural and anthropogenic phenomena, and propose scientifically supported conservation measures. The “Science Market” game effectively combined formative assessment with motivation, reinforcing previously mobilised CL. Overall, 84% of students rated the sequence’s contribution positively. The results confirm the potential of integrating games and gamification into Natural Sciences teaching to enhance motivation, learning, and critical competencies, highlighting the relevance of innovative strategies for addressing environmental challenges in education.

A window into epistemic practices of an online fitness community

Gur Arie Livni Alcasid and Iris Tabak

| Oral |

Keywords: *Scientific Literacy, Epistemic Engagement, Public Engagement With Science*
Submission #: 106

Understanding scientific literacy requires examining how people use and evaluate scientific information in everyday contexts, beyond idealized portrayals of scientific reasoning. Building on the concept of the competent outsider and frameworks of epistemic engagement, this study investigates how laypeople navigate scientific claims in an authentic online discussion. We focus on the debate surrounding the "anabolic window"—the contested claim that protein consumed within 30 minutes post-exercise enhances muscle gain—an issue that avoids strong identity or trust pressures yet invites scientific reasoning. Using Reddit's API, we collected 363 comments from r/Fitness. Each message was coded using the AIR framework along three non-exclusive dimensions: content (claims about biological mechanisms), epistemic (how knowledge is obtained), and meta-epistemic (reflection on the credibility or applicability of evidence). A first-order Lag Sequential Analysis examined how these forms of reasoning unfold in interaction. Content statements appeared in 79% of comments, epistemic in 57%, and meta-epistemic. Users referenced scientific literature, personal experience, and para-scientific experts. Meta-epistemic reflections typically addressed the scope, applicability, and generalizability of research. Lag Sequential Analysis revealed that content statements mainly prompted additional content, while epistemic and meta-epistemic moves mutually reinforced each other, supporting extended evaluative discussions. These findings highlight a sophisticated way in which laypeople try to understand complex biological phenomena in their daily lives. Science and personal experience are intricately connected in a discussion that shows epistemic sophistication. Science education may benefit from using naturally occurring practices to highlight epistemic and meta-epistemic reasoning, thereby better preparing learners for participation in information-rich environments.

Unpacking links between climate literacy and sense of place in a place-based program for bedouin youth

Shaima Alokbe and Orit Ben-Zvi Assaraf

| Oral |

Keywords: *Climate Literacy, Place-Based Education, Sense Of Place, Sustainability*
Submission #: 174

The study examines an after-school, place-based climate education program developed to promote climate literacy among Bedouin youth in the Negev. Its goal is to explore how learning rooted in local environments, community knowledge, and lived experience shapes students' understanding of climate change and their sense of place. The study followed 30 ninth-grade students from rural and semi-urban Bedouin communities in the Negev. The program included two strands: (1) The Climate Crisis and Me, integrating discussions and field visits, and (2) project-based investigations of local climate-related phenomena. Data were collected through pre- and post-interviews, a mixed-format climate literacy questionnaire, student artifacts, and observations. Each student was treated as an individual case; this proposal highlights two focal cases. Findings show that climate literacy developed in close relation to students' environments, socio-cultural contexts, and evolving sense of place. Amal, from a rural traditional community, demonstrated a shift from everyday environmental experience to system-based climate reasoning and applied this understanding within her household and surroundings. Rand, from a semi-urban town, approached climate issues through social relationships and collective responsibility, translating her scientific understanding into community-oriented action. Together, these learning patterns illustrate how distinct senses of place shaped students' climate reasoning and enabled context-sensitive forms of climate agency. The findings demonstrate that place-based climate education can deepen both climate literacy and sense of place, enabling Bedouin youth to connect scientific understanding with locally meaningful forms of climate action.

Learning ecology outdoors: authentic inquiry via citizen science

Nirit Lavie Alon, Tali Tal, Hila Shefet Barkae and Lavi Oren

| Symposia | 1: Tsybulsky: Transforming Biology and Environmental Education through Citizen Science

Keywords: *Citizen Science, Science Education, Inquiry-Based Learning, Scientific Literacy, Outdoor Learning*

Submission #: 40

This presentation explores two school-based citizen science initiatives conducted in outdoor settings, each designed and implemented independently by middle school science teachers. In both cases, the teachers developed their own research frameworks — including study topics, field environments, and collaborations with scientists — and created innovative ecology curricula integrating citizen science principles. They also carried out studies to evaluate the educational impact of these programs on their students. In the first case, an 8th-grade science teacher sought to broaden the learning experience for low-achieving students by engaging them in meaningful outdoor research. His goals were to provide novel, hands-on encounters with nature, encourage exploration of their immediate surroundings, and foster interest in science. In the second case, a 9th-grade honors science class, the teacher aimed to facilitate inquiry-based learning through an authentic, student-relevant research experience that could contribute valuable data to the scientific community. Together, these examples highlight the potential of citizen science as an effective pedagogical approach that enables students to engage in authentic scientific practices, develop inquiry and analytical skills, and enhance their scientific literacy. The presentation will also outline the design principles for school-based citizen science projects developed by the Taking Citizen Science to Schools Center (TCSS). These principles offer practical guidance for educators seeking to design, implement, and sustain citizen science initiatives that meaningfully integrate research and learning while advancing both student engagement and scientific understanding.

Developing biology teachers' pck through inquiry-based microbiology: insights from a training programme

Lara Amorim and Betina Lopes

| Oral |

Keywords: *Teacher Professional Development, Pedagogical Content Knowledge, Microbiology Education, Inquiry-Based Science, Science Instruction*

Submission #: 129

This study examines how a professional development (PD) programme in inquiry-based microbiology supports the development of secondary school biology teachers' Pedagogical Content Knowledge (PCK). Despite Microbiology's strong potential for authentic scientific inquiry, its classroom implementation is often constrained by limited laboratory resources, curricular pressures, and teachers' lack of confidence in conducting Microbiology practicals. The EduBiota PD programme was designed to address these challenges by engaging teachers in authentic laboratory experiences that model inquiry-based practices while strengthening the disciplinary and pedagogical foundations required for effective Microbiology instruction. Ten in-service teachers participated in laboratory-based sessions that combined guided inquiry, collaborative problem solving, and structured reflection on classroom transposition. Drawing on qualitative data from questionnaires, activity-specific surveys, self-observation grids, photographic documentation, semi-structured interviews, and reflective narratives, the study explores how teachers experienced laboratory inquiry, how their pedagogical reasoning evolved, and which components of PCK emerged during training. Preliminary findings suggest a progression from initial uncertainty with laboratory techniques to increased confidence and recognition of the instructional value of Microbiology inquiry. Participants reported enhanced understanding of microbial diversity, biosafety principles, and the relevance of microbiology to everyday contexts such as health and environment. Early thematic analysis indicates that authentic laboratory engagement supports the development of multiple PCK dimensions, including knowledge of instructional strategies, representations, and student challenges. The study contributes insights into how inquiry-based Microbiology PD may foster meaningful curriculum integration and encourage teachers to adopt inquiry-rich practices in their classrooms.

Promoting collaborative biology educators' professional development for embedding climate change and sustainability in the secondary (high) school science national curriculum in england, uk

Ruth Amos

| Oral |

Keywords: *Teacher Professional Development, Sustainable Futures, Collaborative Cross-Subject Pedagogies*

Submission #: 240

Providing opportunities for science students to gain climate emergency awareness and the need for sustainable futures continues to be a challenge for educators across many countries. This study highlights the opportunities for high-quality biology and science teacher professional development (PD) aimed at embedding powerful resources in biology lessons related to climate change and sustainability for 11-16 year olds in England, UK. The study is part of University College London's (UCL) Institute of Education (IOE), Climate Change and Sustainability Centre's development work and evidence-based practice (Greer et al., 2025). The study was conducted using semi-structured interviews with 10 experienced teachers of biology (and science) based in secondary (high) schools in London, UK. Questions explored what teachers wanted from online PD on teaching about sustainable futures. Teachers suggested areas of the biology (and science) curriculum they felt were relevant for embedding ideas about climate emergency and adopting sustainable solutions. A key goal was the co-development of a series of meaningful learning activities, which would engage and inform students, encouraging sustainable personal actions. Collaboration between the school teachers and science educators was successful in designing relevant teaching resources, which teachers adapted for inclusive learning. Examples from the UCL IOE CCCSE online PD module launching in early 2026 will be presented and discussed. Recommendations for the development of the online PD model and its wider impacts will also be presented.

Promoting sustainability through plant-based education: insights from a narrative literature review

Alexandros Amprazis, Nikolaos Galanis, Anastasios Papanikolaou, Panagiota Christodoulou, Anastasia Oikonomou and Penelope Papadopoulou

| Oral |

Keywords: *Plants, Plant-Based Education, Sustainability Education, Narrative Literature Review, Plant Awareness*

Submission #: 59

Plants form the foundation of life on Earth, sustaining ecosystems and supporting the development of human societies. In an era of limited plant awareness, it is worth questioning to what extent this link to sustainable development is fully understood. Recognizing this potential gap in understanding highlights the need to integrate plant-related content into sustainability education. Such integration can provide a meaningful context for comprehending ecological processes and the vital dependence of human life on plants. This study explores how plants are incorporated into education for sustainability through a narrative literature review. Empirical studies that described, analyzed, or evaluated educational interventions using plants to promote sustainability in formal or non-formal learning contexts were reviewed and analyzed. Thirty-eight studies met the inclusion criteria and were categorized according to their primary pedagogical approach and the Sustainable Development Goals (SDGs) they addressed. The analysis revealed that Garden Based Learning and Field/Botanical Garden Inquiry were the most common approaches, representing nearly two thirds (63.16%) of all empirical interventions. The most frequently targeted SDGs were SDG 4 (Quality Education), SDG 15 (Life on Land), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). Other goals, including SDG 1, 5, 7, 8, 9, 10, and 16, were rarely addressed, indicating a narrow scope of educational focus. This finding is significant as it underscores a broad and still underexplored potential to embed plant-related content more deeply within education for sustainability and to strengthen its integrative and transformative impact.

Investigating undergraduate students' conceptions of circular economy practices

Maria Andronikou, Stella Petrou and Konstantinos Korfiatis

| Oral |

Keywords: *Circular Economy Model, Strategies Of The Circular Economy, Higher Education, Teaching Intervention, Sustainability Education*

Submission #: 197

The concept of the circular economy represents an innovative model of sustainable development, primarily aiming at the minimization of resource waste and the enhancement of efficient resource management. Moreover, the implementation of the nine strategies of the circular economy, known as the "9Rs" (refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, and recycle), yields economic, social, and environmental benefits. The present study examined the perceptions of 47 undergraduate female students enrolled in the Department of Education at the University of Cyprus regarding circular economy practices. The main objective was to assess their level of understanding, awareness, and intention to adopt such practices before and after the teaching intervention implemented within the course "EDU175: Natural Sciences in Early Childhood Education: Environment and Living Organisms". Data were collected through a mixed-format questionnaire comprising both closed-ended and open-ended questions, which were subsequently analysed using quantitative and qualitative methods. The findings revealed a significant positive change in participants' knowledge and attitudes toward the circular economy model, as well as their intention to adopt relevant practices, confirming the importance and effectiveness of the educational intervention. Consequently, the study highlights the necessity of integrating sustainability education into higher education curricula and underscores the importance of implementing appropriate pedagogical practices that foster environmental awareness and responsible consumption among learners. Overall, this research contributes to a deeper understanding of the relationship between environmental education and sustainable development within the context of educational practice.

An integrated framework for evaluating students' responses to open-ended questions in biology

Moriah Ariely and Anat Yarden

| Oral |

Keywords: *Scientific Explanations, Assessment, Theory-Based Rubrics*
Submission #: 177

Scientific explanation is a fundamental scientific practice; yet, many students struggle to distinguish explanations from other forms of reasoning, such as descriptions or justifications. These difficulties often result in incomplete, non-mechanistic reasoning about biological phenomena. A contributing factor is the conceptual ambiguity surrounding what qualifies as a scientific explanation. Existing frameworks, such as philosophical accounts of explanation, epistemic operations, and claim-evidence-reasoning (CER), offer valuable and complementary insights into how students reason about scientific phenomena. This study introduces an integrated framework that synthesizes and combines these perspectives to clarify distinctions among explanations, arguments, descriptions, and other types of reasoning, thereby supporting a more coherent analysis of students' written responses. We applied the integrated framework to analyze high-school students' responses to open-ended biology questions that required scientific explanations. Using a qualitative approach, we examined one representative student response in depth to illustrate how the framework functions as a decision-making tool for evaluating the responses. The analysis revealed that students may combine explanatory and other elements within a single response, often providing partial mechanistic explanations alongside non-explanatory responses. These patterns reveal the types of reasoning students use in their responses and where their responses fall short of explanatory expectations. We conclude that our integrated framework highlights the distinctions between explanations, justifications, and other non-explanatory responses, thereby revealing specific gaps in students' causal-mechanical reasoning. It can serve two complementary roles: guiding teachers in designing theory-based rubrics, and supporting evaluators in identifying the specific reasoning gaps that can inform instructional adjustments in biology education.

Creation of comics as evolutionary arenas: tracing reasoning across modes

Johanna Aringer, Kristina Danielsson, Ammie Berglund and

Lars Wallner

| Oral |

Keywords: *Biology, Multimodality, Primary School, Social Semiotics, Teleological Reasoning*

Submission #: 128

Understanding evolutionary processes such as natural selection is challenging for learners, yet research indicates that primary school students can grasp aspects of variation, heredity, and selection. Teleological reasoning—explaining traits as fulfilling a need—may initially support meaning-making in evolution education. Spoken or written verbal language alone cannot fully represent evolutionary processes. Therefore, this study adopts a social semiotic perspective on multimodality, emphasizing how different semiotic modes enable distinct forms of meaning-making. For instance, verbal language is apt for conveying causal relations, while images are more apt for illustrating spatial properties. We investigate how students motivate the evolution of new traits during a comics-making task in a Swedish Grade 4 class (ages 9–10). Data include video recordings, sketches, and final comics from a group of three boys, focusing on one case student, “Anton.” Initially, Anton uses teleological reasoning in oral discussions, arguing that lizards “become armored to survive.” His final comic, however, visually depicts differential survival without explicit teleological explanations, and his oral presentation suggested a shift toward causal reasoning. The findings highlight the importance of analyzing students’ texts and discussions in depth to uncover underlying reasoning. In doing so, teachers should consider modal affordances when supporting and evaluating students’ understanding of evolutionary principles.

Citizenship education through science: which curricular coherence for upper secondary vocational education in french-speaking belgium?

Mercédes Avignon

| Poster |

Keywords: *Citizenship Education, Science Curriculum, Curriculum Emphases, Vocational Education, Secondary Education*

Submission #: 258

The educational system in French-speaking Belgium is experiencing an important overhaul with the implementation of an extended pedagogical continuum until 15 years old included, leading to the rewrite of upper secondary education curricula. However, in 2014, upper secondary vocational education had already undergone a deep rewrite of general courses, including science. The latter aims to form future citizens that contribute to decision-making and act responsibly, in a context of societal and environmental challenges. Given those elements and the coming rewrite of curricula, the main objective of this research is to establish the consistency between citizenship education goal of the science course for upper secondary vocational students and means given to teachers to achieve it. To reach that goal, the research identifies the kind of citizen targeted by the science curriculum introduction regarding Simonneaux & al. (2016) epistemological framework, the societal and environmental challenges mentioned, and the kind of citizen targeted in the prescribed learning through lemmatization and cognitive levels classification of them in reference to the international survey ICCS (IEA, 2009), Sjöström & Eilks (2018, 2020) and Simonneaux & al. (2016) frameworks.

Integrating mathematics into middle-school biology lessons: teachers' pathways to change

Dina Bartov and Anat Yarden

| Oral |

Keywords: *Biology-Mathematics Integration, Teachers' Professional Growth, Interdisciplinary Stem Teaching*

Submission #: 145

Integrating mathematics into biology is increasingly promoted to deepen students' understanding of complex biological phenomena, yet many teachers are products of discipline-specific preparation and work within separated curricula. This study investigates how middle-school biology teachers' professional practice and beliefs change as they implement an interdisciplinary Computational Biomedicine program that integrates mathematics into biology lessons. Drawing on Clarke and Hollingsworth's (2002) Interconnected Model of Professional Growth, we examine change across the teachers' External, Practice, Consequence and Personal domains. Six biology teachers participated in a two-year, 20-session professional development that combined content learning, modeling of integrative pedagogy, and structured reflection, while teaching units from the program. Data sources included three lesson plans per teacher, three semi-structured interviews (end of year 1, mid- and end of year 2), and a year-long reflective teaching journal. Thematic analysis led to selection of two illustrative cases that trace divergent change pathways. Fanny, who initially viewed mathematics as a resource for clarifying biological ideas, engaged in enactment–reflection cycles that led her to enrich tasks with additional quantitative data and shift toward student-centered, small-group inquiry. Anna, in contrast, closely followed the written materials, emphasized technical difficulties, and retained largely fixed beliefs about students' mathematical ability while her practice showed only modest increases in graph and data use. The cases highlight that access to integrated curricula and PD is necessary but insufficient: substantive professional growth requires opportunities and support for iterative enactment and reflection, targeted content support, and explicit work on teachers' beliefs about mathematics-in-biology.

Fostering media competence in stem learning through the creation of explanatory videos – an emprical comparisson

Carla Beckmann, Oliver Böhm-Kasper and Claas Wegner

| Oral |

Keywords: *Media Competence, Explanatory Video Production, Out-Of-School Stem Education, Productive Digital Engagement*

Submission #: 120

Media competence is an increasingly important objective in STEM education, yet empirical evidence on how productive digital activities support its development remains limited. This study examines whether creating explanatory videos in out-of-school STEM courses leads to greater gains in media competence than receptive digital engagement. A total of n = 95 students in grades 4 to 6 participated in inquiry-based out-of-school STEM courses and were assigned either to a treatment group (n = 47), which created explanatory videos, or to a control group (n = 48), which engaged in the same STEM activities using only receptive media. Media competence was assessed using a pre–post instrument based on the KMK framework "Bildung in der digitalen Welt" (2016) (26 items; α pre = .932; α post = .949). To evaluate the intervention's effectiveness, a mixed ANOVA was conducted. The results showed a significant interaction between group and time, $F(1, 93) = 9.795$, $p = .002$, partial $\eta^2 = .095$, indicating differential development across groups. Bonferroni corrected post hoc tests revealed that only the treatment group improved significantly over time $t(93) = –3.406$, $p = .006$, $d = –0.349$, while no significant change was observed in the control group. These findings demonstrate that explanatory video production in STEM contexts has a measurable impact on students' media competence. The results highlight the relevance of production-oriented digital activities in STEM learning contexts and underline their potential for fostering sustainable media-related competencies. Further analyses using linear mixed models will deepen the understanding of the intervention's effects.

Potential of alternative experiment protocol structuring

Philipp Behrens, Anke Meisert and Jürgen Menthe

| Poster |

Keywords: *Fragmented Laboratory Reports, Evidential Reasoning, Cognitive Load*
Submission #: 220

Laboratory reports are challenging writing tasks in lower secondary science lessons, as they require observational and interpretive statements to be integrated into a single, coherent text. For many learners, particularly those with limited academic language proficiency, this can create linguistic and conceptual difficulties. This study examines whether using fragmented laboratory report formats with discrete, visually linked fields for observations, data, and interpretations improves disciplinary learning while avoiding additional cognitive load. Using a controlled pre–post design, 80 Year 8 students completed four lessons ranging from guided modelling to independent documentation. Valid datasets comprised n = 52–55 (between-group) and n = 62–64 (within-group). Outcome measures included conceptual knowledge, scientific reasoning, domain-specific writing, and cognitive load. As several variables deviated from normality, Wilcoxon, Mann–Whitney U and robust Welch tests were applied. Students working with the fragmented format demonstrated significantly greater improvements in conceptual knowledge ($p = .008$/$p = .014$) and transfer reasoning ($p = .004$/$p = .004$) than those using traditional protocols. No significant differences emerged for domain-specific writing. There was no difference in cognitive load between formats ($p > .60$, $n = 78$; combined with the pilot study, $n = 149$). This indicates that the unfamiliar layout does not impose additional mental effort. These results suggest that fragmented documentation can support evidential reasoning and conceptual learning without increasing cognitive demands. By making argumentative connections visible, the format may reduce linguistic barriers while maintaining disciplinary rigour. Limitations include the short intervention and modest sample size. Ongoing analyses will examine learners' writing processes in more detail.

Conception and construction of normality and normativity and the role of biology education

Anthony Benzig

| Poster |

Keywords: *Conceptions, Normativity, Normality, Norms, Diversity*
Submission #: 221

Normality, understood as a culturally, historically, and socially constructed concept, plays a central role in shaping perceptions of difference within different social contexts. In biology education, these normative assumptions become particularly visible, as the discipline directly addresses topics such as bodies, sex/gender, sexual orientation, dis/ability, and distinctions between "healthy" and "sick." Such framings can unintentionally reinforce dominant (hetero)normative, ableist, or binary models, potentially marginalizing students whose experiences diverge from these norms. At the same time, normativity is neither fixed nor neutral; questioning established notions of normality offers opportunities to reduce "Othering"-processes and support students' identity development and critical thinking. To understand how students construct and conceptualize normality and normativity, a scoping review (with Web of Science and ERIC) was conducted following established methodological frameworks. Two research questions guided the review: (Q1) Which constructional processes of (a) normality and (b) normativity are reported in empirical and analytical studies? and (Q2) What conceptions of students regarding (a) normality and (b) normativity are described in the literature? The analyzed studies demonstrate that normality is pluralistic, context-dependent, and closely tied to socio-cultural power structures. Constructions of normality frequently relate to disability, gender/sexuality, and social hierarchies. Three categories of norms were identified, that are used to construct Normality: (a) biological/medical norms, (b) socio-cultural and interactive norms, and (c) hierarchical and power-based norms. These insights emphasize the need for diversity-oriented teaching approaches that avoid reinforcing a "standard vs. deviation" and instead highlight the natural variability of human experiences. Further conclusions will emerge as the review progresses.

An empirical study of upper secondary students' learning with visualizations of hexokinase

Arvid Lobato Berg, Kristina Zinger and Carl-Johan Rundgren

| Poster |

Keywords: *Visualizations, Upper Secondary School, Enzymes, Biochemistry*
Submission #: 23

Different kinds of visualizations are both common and important in biology teaching. In this study, new lesson materials focusing on visualizing hexokinase were developed and tested. According to Rundgren and Tibell (2010), teaching with visualizations involves three parts: the intended object of learning (IOL); the teacher's learning goals, the enacted object of learning (EOL); how this knowledge is conveyed through teaching and visualization, and the lived object of learning (LOL); the students' interpretation and resulting learning. Furthermore, intrinsic critical features (iCF) is the knowledge used by the teacher when creating the EOL, and extrinsic critical features (eCF) are colors, shapes and other external traits that convey knowledge in a visualization (ibid.). This study addresses the research question: How did the students interpret the critical features of the visualizations? To investigate this, the lesson material was tested in three upper secondary schools in Sweden. Participatory observation and thematic analysis was used in order to collect and analyse the data. The analysis showed that the students' language use varied between different kinds of activities when discussing visualizations' eCF. When given a written assignment, the students used scientific biology terms, but when they built their own enzyme models the language shifted to a use of more informal terms. The EOL affects how the students speak about biochemistry, and so the teacher must reflect on what language use is most suitable for conveying the IOL.

Building action competence through action-oriented sustainability teaching in biology teacher education

Teresa Berglund and Peter Lampert

| Symposia | 7: Lampert: Action-Oriented Teaching for Biodiversity: Exploring Dynamics of Change

Keywords: *Sustainability Education, Biology Teacher Education, Biodiversity, Action-Orientation, Action Competence*

Submission #: 199

The global sustainability challenges require that teachers move beyond acquisition of knowledge and skills to equip pupils with the ability to make informed decisions and strengthen their motivation to engage in the sustainable development of society. This study investigates how biology student teachers' competence to teach action-oriented sustainability can be developed. The study first shows changes made to the existing course Education and Learning for Sustainable Development to strengthen the action-orientation and use of local contexts for student teachers in biology and science studies. The new course design was tested in two rounds with subsequent revisions based on students' reflections on their learning and future teaching. The findings indicate that students' perception of sustainability teaching changed, not only in terms of what the concept of sustainability entails, but also their perception of the objectives of sustainability education. Students found the local and action-oriented approach highly relevant, however, they saw challenges in translating it into practice. A number of obstacles for application into future teaching were highlighted that had to do with preconceptions of teaching in school such as perceived financial and time limitations, and university education as promoting an idealized and unrealistic view of teaching. This suggests that forthcoming course revisions should explicitly address perceived obstacles to promote students' confidence to facilitate use of local and action-oriented approaches at schools. This oral presentation is part of the symposium: 175. ACTION-ORIENTED SUSTAINABILITY TEACHING: STAKEHOLDER PERSPECTIVES ON OPPORTUNITIES AND CHALLENGES

Exploratory study on system-related knowledge of pre-service biology teachers

Alexander Bergmann and Cornelia Averdunk

| Oral |

Keywords: *Systems Thinking, Conceptual Knowledge, Metastrategic Knowledge, Pre-Service Teachers, Teacher Training*

Submission #: 16

Systems thinking is a central goal of biology education, as it enables learners to model biological phenomena based on general system characteristics. To foster students' systems thinking effectively, biology teachers must possess both conceptual knowledge about (biological) systems and their properties, and meta-strategic knowledge — that is, knowledge about when and how systems thinking can be applied as an appropriate cognitive strategy. Despite its curricular importance, empirical evidence on pre-service biology teachers' system-related knowledge remains limited. This exploratory study investigates the system-related conceptual and meta-strategic knowledge of first-year pre-service biology teachers at a German university (N = 120, M = 20.2 years, SD = 3.2, 72% female). Data were collected using a standardized open-ended questionnaire comprising six questions. Responses were analyzed in two coding cycles by means of qualitative content analysis and subsequent frequency analyses. The findings indicate that participants refer to only a few system properties, such as interactions and feedback, and often describe them in a simplified or scientifically inaccurate manner. Moreover, none of the participants were able to characterize systems thinking appropriately from a disciplinary perspective. Instead, they often equated it with rule-based or taxonomic reasoning. These results suggest that pre-service biology teachers possess only limited system-related conceptual and meta-strategic knowledge. The study highlights the need for targeted professional development during the early stages of teacher education to promote a biological understanding of systems thinking and its pedagogical application.

Action or reflection? developing an instrument to examine esd approaches through pre-service biology teachers' beliefs

Vivien Bernhardt and Matthias Wilde

| Oral |

Keywords: *Education For Sustainable Development, Pre-Service Teachers' Beliefs, Esd Beliefs, Critical-Reflective Esd, Instrument Development*

Submission #: 116

Biology education is commonly attributed with strong potential for supporting sustainability-related learning processes. At the same time, the associated construct of Education for Sustainable Development is conceptualized in various ways within science education research, and only limited empirical work has examined the underlying conceptual structures. Although the distinction between more action-oriented and more critical-reflective ESD approaches has been outlined theoretically, instruments that capture corresponding belief structures among (future) teachers remain rare. This study aimed to develop and validate a theory-based questionnaire assessing beliefs about ESD. Two samples were surveyed. 218 students are enrolled in biology teacher education programs and 102 are in their first semester of biology-related programs. An initial set of belief statements was created, evaluated by experts, and refined through a pilot study. An exploratory factor analysis identified a compact two-factor solution of nine items, accounting for 52% of the variance (KMO = .87). The first factor captured beliefs relating to societal and uncertainty aspects of sustainability, whereas the second reflected instructional and action-oriented beliefs. Reliability indices indicated good to acceptable internal consistency. A confirmatory factor analysis in the second sample supported this structure with good model fit. The results demonstrate that the instruments depict two ESD-related dimensions and provides a foundation for further quantitative research into how ESD is conceptualized.

Promoting artenwissen and coherence in biology teacher education – results from the first cohort of a design-based research study

Tom Bewersdorf and Carolin Retzlaff-Fürst

| Oral |

Keywords: *Species Knowledge, Species Literacy, Artenwissen, Coherence, Design-Based Research, Pre-Service Biology Teachers*

Submission #: 171

In parts of society, as well as among biology pre-service teachers, there is a low to moderate level of species knowledge with regard to various groups of organisms. In additon the fragmentation of structures and content in teacher education, particularly between and within the various facets of professional knowledge, makes it difficult to develop a connected knowledge base. Creating coherence is one way of interlinking study structures and subject content as well as promoting knowledge procession. This article presents an excerpt from a design-based research study. The focus is on investigating the effect of perceived coherence, both within subject-specific courses and between subject-specific and subject-didactic courses (intervention), on the development of Artenwissen as a further framework for the dimensions species knowledge, Formenkenntnis and in-depth knowledge applied here. Previous results show that the perception of coherence within subject-specific courses correlates significantly with the knowledge gained in the performance tests. However, the three dimensions show different patterns of correlation. Therefore the differentiation of Artenwissen appears to be applicable. The aim of the intervention (biology didactic seminary) is to establish coherence in relation to Artenwissen with references to bioscientifical and biology-didactical perspectives. For this purpose, elements of situated learning, boundary crossings and explicit relationings are applied.

Simulations as epistemic tools: a machine learning-based analysis of students' uncertainty descriptions

Simon Blauza, Kerstin Kremer and Benedikt Heuckmann

| Oral |

Keywords: *Navigating Uncertainty, Nature Of Science, Computer Simulations, Machine Learning, Biology Education*

Submission #: 96

Uncertainty is central to science and the ability to navigate uncertainty becomes a key requirement for science education. A recent framwork propose three competency areas in navigating uncertainty: understanding, managing, and reflecting on uncertainty. Conceptualizing computer simulations (CS) as epistemic tools that allows to reflect the nature of science (NOS), this study examines how learners describe uncertainty after interacting with CS. In an exploratory, cross-sectional study, n = 161 biology students completed an online questionnaire after interacting with a CS, which differed in complexity (clear/complicated vs. complex/chaotic) and biological context (e.g., immunobiology–herd immunity). Responses were analyzed using computational grounded theory, natural language processing, and machine learning (ML) to detect recurrent patterns, with analyses run separately by complexity condition. The analysis yielded 18 clusters for the clear/complicated simulations representing groups of students' uncertainty descriptions; frequently observed clusters emphasized (I) uncertainties introduced by parameter limitations and (II) uncertainties arising from simplified or random parameters. Findings suggest that CS can serve as a reflective tool to support students in articulating uncertainties and that ML-assisted analysis is effective for mapping learners' descriptions of uncertainty. Furthermore, the findings may support the identification of potential levels within the competence domain of understanding uncertainty, akin to similar constructs such as modeling competence. This could enable a target group-specific analysis of uncertainty in CS in biology education.

Rolling dice in parsimony: cultivating playful tree-thinking in secondary biology education

Lorenz Boeckhorst and Roald Verhoeff

| Oral |

Keywords: *Evolution, Tree-Thinking, Playfulness, Educational Board-Game, Design Based Research*

Submission #: 105

Understanding phylogenetic trees - or tree-thinking - is central to grasping evolutionary theory. Various misconceptions hinder students' use of phylogenetic trees. To address these challenges, this study adopts a learning-through-play approach. We designed Parsimony, a board game that immerses biology students in an inquiry context of paleontological reasoning. The game prompts students to reconstruct cladograms, simplified phylogenetic trees emphasizing species' relative relatedness. Expert-like practices are encouraged by incrementally integrating randomly 'discovered' beetle species. Using an Educational Design Research approach, we tested two groups of upper-biology level students (3 students each, ages 16-18) and two classes (of 13 and 21 students). Video and audio recordings, student worksheets, and interviews with students and teachers were analyzed by adopting coding schemes for tree-thinking and playfulness. Findings indicate that embedded challenges foster expert-like activities: students discussed undefined trait annotations, implemented trait loss and developed heuristics for partial parsimony. Playfulness was notable and productive when maintained, with groups continuing the narrative, students imagining and predicting possible undiscovered species, and groups aligning their thinking to come to shared solutions. When play context collapsed, learning opportunities diminished. We conclude that successful immersion in a well-scaffolded play environment can cultivate tree-thinking for secondary biology students. This study contrasts previous research suggesting to present students predefined algorithms. The approach shows promise for other thinking skills in biology education (e.g. systems thinking). Further research could explore how transfer of such thinking skills from 'magic circle' to domain specific ontology can be strengthened.

Revolutionizing qualitative research: ai-assisted analysis of student conceptions on microplastics

Justus Braune, Cathérine Conradty, Franz Xaver Bogner and

Jürgen Paul

| Oral |

Keywords: *Microplastics, Students' Conceptions, Conceptual Change, Qualitative Analysis, Artificial Intelligence*

Submission #: 25

Knowledge about students' conceptions is crucial for effective teaching. Students' conceptions are typically captured by applying qualitative methods which was challenging in the past due to time-consuming analyses. Nowadays, a potential time-saving game-changer for qualitative analysis emerged with the release of ChatGPT 3.5. In this study, we show the supportive role of artificial intelligence (AI) in qualitative analyses by describing the way of categorizing conceptions of 180 students. ChatGPT-o1 was shown enabling to generate a valid category system and to produce accurate classifications, while significantly reducing analyses time. Two independent AI runs yielded highly consistent classifications, with inter-rater reliabilities of up to $\kappa = 0.96$, surpassing those of traditional two human coders ($\kappa = 0.45$–0.9). Overall, our participants rarely differentiated microplastics (MPs) by shape or type but primarily expressed negative associations. MPs were mostly described by size and visibility and were predominantly perceived as an aquatic issue. Other affected areas such as air and soil were mentioned less often. Participants most frequently identified personal care products and packaging as the main sources of microplastics and rated the risk of MPs as high or very high, higher than current research suggests, possibly influenced by media reporting. These insights may contribute to the design of more targeted lessons on microplastics, aiming to address prevalent conceptions in future science education scenarios and to emphasize the role of effective science communication.

Chatgpt as a tool to support secondary school students in formulating research questions within a crispr-cas biotechnology research laboratory context.

Lies Vanden Broeck, Silke Sterck, Lieve Moeyersons and

Marion Crauwels

| Oral |

Keywords: *Biotechnology, Research Questions, Ai-Literacy*

Submission #: 149

ChatGPT is widely used by secondary students in their STEM subjects, however these students show limited knowledge of this tool (Valeri et al, 2025) Lo, 2023 developed the CLEAR (concise, logical, explicit, adaptive, reflective) framework to guide students in prompt engineering and support critical thinking in a changing artificial intelligence (AI) landscape. Mapping critical thinking skills in students was described by Garrison et al 2001. The practical inquiry (PI) model provides a coding scheme for researchers to capture the phases cognitive presence of students' learning. In this study, we investigated whether 12thgrade secondary students could be taught how to effectively prompt ChatGPT to formulate scientific research questions during a CRISPR-Cas biotechnology inquiry-based research. In the first week, the teacher introduced the characteristics of a high-quality research question and how to apply the CLEAR framework by guiding students' prompting of ChatGPT. In the second week, the CLEAR framework on how to prompt ChatGPT to obtain research questions was repeated. A post-test was conducted in which the students were asked to identify a new high-quality research question on a different topic. We then examined students' prompts by applying the PI-model coding scheme. Our study revealed that all students were able to use ChatGPT to formulate scientific research questions and 11% of participating students displayed full cognitive presence. Most participating students showed the exploration phase, we thus believe that our data supports previous studies, indicating that using ChatGPT promotes students' engagement (Heung et al, 2025).

Perceptions of present and future forests among students with and without special educational needs

Lisa-Marie Broghammer, Melanie Basten, Laura Ferreira González, Anne Reh, René Schroeder, Daniela Sellmann-Risse, Hannah Weck and Silvia Fränkel

| Oral |

Keywords: *Students' Perceptions, Forest Ecosystems, Sustainable Future Visions, Special Educational Needs, Education For Sustainable Development, Draw-And-Explain Approach*
Submission #: 170

As forest ecosystems are increasingly affected by climate-driven disturbances (Seidl et al., 2017), understanding students' perceptions of present and future sustainable forests is crucial for supporting conceptual change (Duit & Treagust, 2003). Research indicates that children often focus on biotic elements and imagine greener, less polluted futures (Flowers et al., 2015; Stokas et al., 2017). As far as we know, no empirical research has examined these perceptions, particularly among learners with special educational needs (SEN; learning or socio-emotional support needs), despite growing emphasis on subject-specific learning in special education (Pugach et al., 2020). This qualitative study investigates these perceptions among German Grade 7/8 students. Thirty-five students participated (51.4% without SEN; 34.3% learning SEN; 11.4% socio-emotional SEN; 2.9% both). Using Shepardson's (2005) Draw-and-Explain approach, each student produced two drawings (present forest; sustainable future forest) and completed a semi-structured interview. Data were analysed using qualitative content analysis with inductive category formation (Kuckartz, 2019). The findings presented here refer to the pilot sample (N = 19). Most students (84%, N = 16) perceived the present forest as endangered, mainly due to litter and deforestation (62.5%, N = 10), while abiotic stressors were mentioned less often (25%, N = 4) and biotic factors not at all. Students without SEN showed more differentiated ecological perceptions, whereas learners with learning SEN offered simplified explanations, and students with socio-emotional SEN expressed more affective responses. Future forests were idealized by 79% (N = 15), frequently described as pollution-free (52.6%, N = 10) and linked to human responsibility (84.2%, N = 16). Institutional protection roles appeared only among students without SEN (21%, N = 4), while imaginative protective figures were described only by students with SEN (15.8%, N = 3). Students relied heavily on visible anthropogenic cues and overlooked ecological processes, highlighting the need for instruction that makes ecological relationships explicit and fosters systems thinking, particularly in inclusive contexts (Verhoeff et al., 2018).

Board game to raise awareness of emerging diseases spread by mosquitoes and sand flies in spain

Sandra Carballeda, Ángela Bermejo and Rosa Gálvez

| Poster |

Keywords: *Game-Based Learning, Dipteran Vectors, One Health, Gender Perspective, Ecosocial Awareness*

Submission #: 107

This study presents the design and validation of DIVER (Dipteran Insect Vectors for Emerging Risks), a cooperative educational board game aimed at students aged 11–12 in the final year of primary education. Its goal is to raise awareness of emerging diseases in Spain—such as leishmaniosis, dengue, west Nile virus, and malaria—transmitted by dipteran vectors. Grounded in scientific literature, the game features cards based on reports and scientific articles provided by experts from DIVER (working group of the Spanish Society of Parasitology, SOCEPA), and it is aligned with the current national curriculum framework (LOMLOE). Through a Game-Based Learning (GBL), it integrates a One Health approach and gender perspective. The game includes a board, coloured dice, a risk level tracker (no risk, isolated cases, outbreak, epidemic, pandemic), informative and action cards, Spanish province tokens, and professional roles—mostly female—representing healthcare, scientific, and educational fields. Players aim to prevent disease spread by acquiring treatment and prevention cards and leveraging the special abilities of each professional role. DIVER, through an innovative strategy, seeks to enhance motivation by positioning students as active agents in the prevention of nearby diseases. It also fosters ecosocial awareness by linking the emergence of vector-borne diseases to global change and its impact on public health. Additionally, the game aims to inspire scientific vocations and reduce the gender gap in STEM fields. Following the success of the physical version, a digital app has been developed to expand its reach, facilitate dissemination, and adapt to hybrid educational environments.

Representations of evolution in portuguese science textbooks

Bento Cavadas and Bruno Sousa

| Poster |

Keywords: *Evolution, Face Framework, Science, Textbooks*

Submission #: 22

This study investigates how evolution and its core concepts are represented in Portuguese school textbooks for grades 7 to 9, published between 2018 and 2025. Using a mixed-method approach, we analyzed the two most widely used science textbooks in Portugal, applying a deductive content analysis based on the FACE framework. Results reveal that while categories such as "History of Life" and "Evidence for Evolution" are consistently present, discussions on "Mechanisms of Evolution" and "Studying Evolution" are limited and vary across grades. In particular, the 9th-grade textbooks show increased coverage of mechanisms, often illustrated by examples like the impact of antibiotics on bacteria. Overall, despite recent curriculum updates, the depth and scope of evolutionary content remain insufficient in textbooks, especially in foundational topics. These results highlight the need for curricula and textbooks to more comprehensively address key evolutionary concepts from early grades, establishing a solid foundation for more advanced understanding in high school.

Child participation in climate assemblies: success factors and insights from a study in the uk

Gisela Cebrián and Justin Dillon

| Oral |

Keywords: *Climate Assemblies, Child Participation, Community-Based, Key Success Factors, Lessons Learned*

Submission #: 271

Climate citizen assemblies have emerged as innovative forms of deliberative democracy, providing participatory spaces for engaging citizens in climate-related decision-making. However, most assemblies to date have focused on adults, reflecting an adult-centric paradigm that excludes children and young people from these democratic processes. In recent years children's climate assemblies deliberating on climate adaptation, mitigation, biodiversity loss, and related environmental issues are being organised to address this gap, recognising the importance of integrating children's views and proposals into climate policy developments. Yet, while research on adult assemblies is expanding, empirical evidence on children's participation and lessons learned from child-centred initiatives remains limited. This paper presents the findings from an exploratory qualitative study examining the experiences of leaders and key actors involved in the design, facilitation, implementation, and evaluation of recent climate assemblies implemented in school and community contexts in the United Kingdom. The study aimed to (1) learn from the experiences and implementation paths of existing initiatives, and (2) identify success factors, strategies, and conditions necessary for effective implementation of climate assemblies with children. Semi-structured interviews with 14 leaders of 11 assembly initiatives were conducted, with data analysed through thematic analysis. Twenty-two inductive categories were generated and grouped into five themes: (1) sustainability and feasibility of child-led projects; (2) supportive and flexible structures; (3) strategic planning, design, and implementation; (4) engagement factors; and (5) forms of engagement and participation. Findings highlight the need for adequate resources, innovative partnerships, and sustained institutional commitment to ensure children focused climate assemblies move beyond one-off events. Safe, inclusive, and accessible spaces that promote trust, emotional wellbeing, and intergenerational collaboration are essential, supported by flexible facilitation, mental health support, and attention to diverse needs, including those of neurodivergent and underrepresented groups. Addressing systemic educational and policy barriers is critical for enabling schools and communities to act as democratic hubs. Tokenistic involvement undermines legitimacy, underscoring the importance of authentic child participation. Key implications drawn from this study include shifting to child-led and intergenerational models, embedding young people in co-design and governance, adopting inclusive and intersectional approaches, ensuring clear communication and feedback, and establishing more comprehensive and longitudinal evaluation frameworks.

Outdoor learning in a protected area: insights from urban youth

Petra Bezeljak Cerv and Andrea Möller

| Oral |

Keywords: *Urban Environemntal Education, Conncetedness With Nature, Middle School Students, Green Time, Screen Time*

Submission #: 181

Re-establishing a meaningful human–nature relationship is essential for fostering sustainable behavior, particularly among young people growing up in urban environments. While outdoor experiences are known to support nature connectedness, many adolescents spend limited time outdoors and increasing time using digital devices. This study investigates how a structured outdoor learning intervention in a protected area shapes middle school students' experiences of nature, how these experiences relate to nature connectedness, and how they correlate with students' everyday green time and screen time. The study involved 161 urban middle school students (46.6% female; MAge = 13.86, SD = 0.77) who participated in a half-day field trip comprising three stations led by outdoor educators: an introduction to biodiversity, a guided ecological hike, and experiential activities focusing on biodiversity and interdependence. Students completed a post-visit questionnaire including the Inclusion of Nature in Self (INS) scale, items on green time and screen time, and two open-ended questions regarding insights gained and aspects they liked most. Students most frequently reported experiences related to animals, followed by activities, plants, ecological concepts, aesthetic impressions, and encounters with natural processes such as death. Many described first-time experiences and noted limited opportunities to visit protected areas in daily life. Students with lower nature connectedness reported slightly more negative aspects, though overall responses were predominantly positive. These findings underscore the importance of regular outdoor learning opportunities in fostering nature connectedness and supporting Education for Sustainable Development in urban school contexts.

Action-oriented teaching for biodiversity: exploring dynamics of change

Carole Chappuis

| Symposia | 7: Lampert: Action-Oriented Teaching for Biodiversity: Exploring Dynamics of Change

Keywords: *Action-Oriented Teaching, Biodiversity Conservation, Agency, Change, Cultural Historical Activity Theory*

Submission #: 125

Biodiversity is facing unprecedented degradation around the globe. Education is recognized as a strategic lever to address biodiversity loss, yet translating this into formal school practices remains challenging. The topic of biodiversity conservation fits well within sustainability education due to its complex and controversial nature. In this field, research emphasizes action-oriented teaching as a suitable approach to address sustainability issues at school. However, little is known about teachers' perspectives when implementing this approach. This study investigates how action-oriented teaching emerges and drives change for biodiversity in compulsory school settings in Sweden. Nine interviews with teachers who engaged in conservation initiatives through the support of a national nature conservation association were analyzed through the lens of Cultural Historical Activity Theory (CHAT). Findings reveal that contradictions—such as lack of biodiversity in school environments and students' weak connection to nature—triggered teachers to initiate actions like building insect hotels, seed bombs, and school gardens. These efforts fostered student enthusiasm, influenced families, and attracted support from municipalities and local experts. Projects often expanded school-wide, though they placed heavy demands on teachers. The nature protection association provided essential resources but remains under-recognized as a key partner. Schools can catalyze systemic change for biodiversity conservation through action-oriented teaching. However, explicit recognition of teachers' contributions and stronger partnerships with conservation organizations are crucial for sustaining these dynamics. Comment : Belongs to the symposium ACTION-ORIENTED SUSTAINABILITY TEACHING: STAKEHOLDER PERSPECTIVES ON OPPORTUNITIES AND CHALLENGES

Using the risk matrix as a didactical tool for teaching socioscientific issues in science education

Nina Christenson

| Poster |

Keywords: *Socioscientific Issues, Risk Matrix, Risk In Science Education*

Submission #: 212

Socioscientific issues (SSI) offer a powerful context in science education for engaging students with complex, uncertain, and value-laden problems. Although many SSI inherently involve dimensions of risk, research shows that risk is rarely addressed explicitly in classroom practice, despite its central role in scientific literacy and democratic decision-making. Studies in risk and climate education further demonstrate that students' understandings of risk are shaped not only by cognitive assessments but also by emotional and ethical considerations, highlighting the need for pedagogical tools that can support students in navigating these intertwined dimensions. Yet teachers often lack structured didactic resources for working with risk in SSI contexts. This theoretical and conceptual contribution examines the risk matrix as a didactic tool for supporting structured reasoning about risk and decision-making in science education. Drawing on research in SSI, risk education, climate change education, and risk analysis, the presentation integrates core components of risk with decision-making elements involving knowledge and values. Examples from contexts such as climate change and biotechnology, demonstrate how the matrix can help students articulate uncertainties and consider diverse stakeholder perspectives. The presentation suggest that the matrix provides a concrete representation of uncertainty, bridges subjective and objective dimensions of risk, and supports reasoning that links personal experience with wider societal challenges. Integrating the risk matrix into SSI instruction offers a promising approach for strengthening students' decision-making competence and fostering engagement with contemporary societal risks.

The wolf : neither good nor evil. a case study of a museum exhibition as a didactic device to explore children's relationship to animals and the construction of scientific knowledge

Cora Cohen-Azria

| Oral |

Keywords: *Didactic Of Science, Museum, Children'S Relationship To Animal, Image Of Science, Anthropomorphism, Scientific Discipline, Multimodality*

Submission #: 38

This study lies within the field of didactic of sciences and explores how museum exhibitions can contribute to shaping children's relationship to science through their understanding of animals. It is based on a case study of the exhibition The Wolf: Neither Good nor Bad, presented at the Natural History Museum of Lille (France). Designed for preschool and primary school audiences, the exhibition has the particularity of combining both scientific and literary approaches to the figure of the wolf. This dual perspective offers a rich context for examining how scientific knowledge and cultural representations intertwine in the construction of children's ideas about living beings. The research question guiding this work is: How can a museum exhibition that combines literary and scientific dimensions contribute to the development of a scientific relationship to animals among young children? Within a participatory research framework, the researcher attended all design meetings, conducted interviews with exhibition designers, and observed classroom visits before and during the exhibition. The corpus includes diverse data sources (meeting recordings, designers' reports, working documents, interviews with pupils, classroom observations, and a didactic analysis of the exhibition). The analysis highlights the complementarity between didactic, museological, and cultural approaches in supporting the construction of scientific concepts. It also underlines the role of narrative, multimodality, and mediation in shaping both scientific and symbolic representations of animals. The results invite reflection on how museum-based learning can articulate sensory, cultural, and scientific dimensions to foster inquiry and meaning-making in early childhood.

“it feels like i’m touching the soil!” steam gardens for a transdisciplinary and transformative science education

Laura Colucci-Gray and Jonathan Hancock

| Symposia | 2: Dillon: Culturally Responsive Biology Education

Keywords: *Steam, Gardens, Climate Change*

Submission #: 53

In the face of growing ecological crises, there have been calls for transdisciplinary approaches that foreground knowledges and ways of being rooted in community, local/indigenous languages and place. However, systemic injustices that continue to silence those who do not fit in with discipline-specific content and abstract norms, remains an ongoing, cultural challenge for science education. This paper presents a longitudinal ethnographic study involving nine students and their teacher engaging in a gardening group at a secondary school in Scotland. Building on literature on school gardens as ecologies of agency and activism, transdisciplinary practices across Sciences Technologies, Mathematics, Engineering and the Arts (STEAM) engage students in relational and material-aesthetic inquiries centred on food growing, crafting and cooking over the course of a school year. Employing a relational materialist lens, findings point to making practices that re-centre sensory, embodied and experiential knowing as pivotal to re-view science education from a perspective of relationality and reciprocity. STEAM gardens emerge as sites of transformation: how can we re-imagine the school environment and what place for gardens in science education?

Revealing sustainability citizenship: an ai-enhanced residual method for large-n qualitative concept analysis

Cathérine Conradty and Franz X. Bogner

| Oral |

Keywords: *Sustainability Citizenship, Sc Competencies, Conceptual Change, Qualitative Analysis, Ai-Enhanced Analysis*

Submission #: 242

Understanding how learners conceptualise sustainability and sustainability citizenship is central to science education and Education for Sustainable Development (ESD). Existing research relies either on small-N qualitative studies with depth but limited generalisability or on large-N quantitative surveys that flatten conceptual nuance. This study bridges this gap by combining qualitative concept analysis at a comparatively large scale (N = 164) with Large Language Model (LLM)-assisted coding and residual-based matrix analytics. Two open-ended questions asked participants to describe a sustainable future and their desired role within it. Responses were coded using sustainability competencies (Wiek et al., 2011) and either sustainability dimensions (Q1) or role conceptions (Q2). Coding followed a hybrid workflow in which LLMs produced preliminary categories that were validated through structured human review. Human - AI agreement was high (Cohen's κ = .77–.95), showing that LLMs can support qualitative analysis reliably when guided by clear coding frameworks. To reveal latent conceptual structures, four cross-tabulation matrices (competence × competence, competence × dimensions, competence × roles, dimensions × roles) were analysed using standardised residuals, χ^2 and Cramer's V. Distinct conceptual clusters and disciplinary "fingerprints" emerged: Educators showed a normative-reflective pattern, Scientists and engineers a systemic-anticipatory one, and Business & Law students a strategic-cooperative one. Ecological action appeared frequently but was rarely linked to competence claims, indicating an ecological competence gap. Methodologically, the study shows that LLM-supported coding combined with residual analysis enables rich, scalable and replicable insight into sustainability conceptions. This approach offers a powerful direction for field-sensitive ESD research and practice.

From critical reasoning to critical action: a one health design-based research

Irene González Costa, Blanca Puig and Paloma Blanco Anaya

| Poster |

Keywords: *Critical Thinking, Design-Based Research, Microbiota, One Health*
Submission #: 18

Developing critical thinking (CT) in science education is vital today; therefore, training teachers in learning design is essential to achieve this goal. This study adopts a Design Based Research (DBR) approach to engage pre-service secondary school teachers in designing and implementing a learning sequence that promotes CT and understanding microbiote through the One Health (OH) approach. The microbiota was selected due to its status as a salient, current socio-scientific issue (SSI) frequently discussed in public discourse. Furthermore, it provides an opportune context for exploring the OH concept, which posits a reciprocal interrelationship and influence among human, animal, and environmental health. The final learning sequence was developed through the systematic application of iterative cycles involving design, classroom implementation, and subsequent reflective analysis of the activities, characteristic of the Design-Based Research (DBR) methodology. This LS, centered on the microbiota within the framework of the One Health (OH) approach, was deployed in a 9th grade biology classroom. This research highlights the usefulness of DBR as a fundamental link between educational research and teaching practice. Thus, DBR could be considered an indispensable strategy for the professional development of science educators in the contemporary context of the post-truth era.

Effect of digital activity on hight school students' understanding of chance and evolution

Magali Coupaud, Claire Coiffard, Fabienne Paulin and

Jérémie Touze

| Oral |

Keywords: *Understanding Evolution, Chance, Digital Learning, Learning Experience*

Submission #: 108

This pilot study investigates the impact of the “Heureux Hasard” digital application on high school students’ understanding of genetic drift, their understanding of chance, and their learning experience. Genetic drift is a central yet challenging concept in evolutionary biology, largely because it involves probabilistic mechanisms that students often misunderstand. The study involved French high school students in a pre-test and post-test, divided into a control group (traditional instruction) and an experimental group (digital activity). Results show that, despite random assignment, several significant differences existed between the two groups at the pre-test stage, limiting some direct comparisons. However, for factors with equivalent baseline levels, analyses indicate that traditional instruction led to significant improvements in understanding genetic drift, whereas the digital activity did not. Conversely, the digital activity had a positive effect on students’ probabilistic understanding of chance, while the control group showed a decline in this area. Regarding learning experience, students in the control group reported higher levels of engagement and interest than those using the digital activity, although no difference was found for the challenge factor. Overall, the findings suggest that while the “Heureux Hasard” application supports probabilistic reasoning about chance—a key component of evolutionary thinking—hands-on activities may provide a more engaging learning environment. Further research with better-balanced groups is needed to consolidate these results.

Addressing plant awareness disparity by enhancing scientific process skills and plant knowledge

Marion Crauwels, Silke Sterck, Arthur Foqué, Robbe Mertens,

Lieve Moeyersons and Lies Vanden Broeck

| Oral |

Keywords: *Plant Awareness Disparity, Scientific Process Skills, Teacher Education*

Submission #: 154

Despite the central role of plants in many socio-scientific issues such as genetic engineering and climate change, plants are often not appreciated. A symptom of plant awareness disparity in education is that teachers often ignore plants as a subject while teaching which leads to a lack of knowledge and awareness about the important role of plants in socio-scientific issues. To fully engage in an informed discourse on plant socio-scientific issues, one must also develop scientific process skills to understand how knowledge is constructed. This study explores a multi-phase inquiry-based intervention with hands- and minds-on activities that addresses preservice teachers' knowledge of plants and scientific process skills. Twenty-nine secondary biology preservice teachers participated in an exploratory pre-post designed study over a period of six months. Students had to evaluate given claims regarding plant socio-scientific issues and had to design, perform and report on self-designed plant socio-scientific open-ended investigations. The experimental design ability test (EDAT) and assessment rubric (AR) were used to assess the quality of the applied scientific process skills, while a three-tier test was used to gain insight in students' conceptual understanding. A significant positive effect on preservice teachers' understanding of plant physiology and on scientific process skills was found. The results suggest that these preservice teachers became competent designers of open-ended investigations that can cultivate plant significance in socio-scientific issues. These findings advance the overarching aim of preparing future teachers with the competencies necessary for high-quality, research-informed biology teaching in secondary education.

Comparing two ai-driven approaches to formative assessment in evolution education

Berrit Katharina Czinczel, Merav Siani, Moriah Ariely, Anat Yarden and Ute Harms

| Symposia | 4: Harms: Advancing Evolution Learning – Novel Conceptual and Methodological Approaches to Evolution Education

Keywords: *Evolution Education, Conceptual Learning, Ai-Supported Scoring, Formative Assessment, Feedback*

Submission #: 201

This proposal outlines the comparison of two AI-supported approaches to formative assessment within evolution education. The research thus addresses persistent challenges in teaching evolutionary concepts, including student misconceptions and difficulties with the conceptual complexity of the topic. As formative assessment and feedback have proven to be beneficial yet challenging to implement, we propose to support the process through the use of AI. Two different AI-supported approaches are compared: The first creates binary patterns from automatically scored answers to the ACORNS instrument and the second performs a cluster analysis on the scores of student responses to open-ended evolution questions. Both approaches were presented in previous studies. The present study was conducted with a sample of first-year students at different universities. N = 102 students answered both the ACORNS items from the first approach and the open ended questions from the second approach. For the analysis, we are comparing (1) the scoring schemes, (2) the distribution of students from this study across patterns (approach 1) and clusters (approach 2), and (3) the results of this study with previous work. Data collection for this study is finalized and the results will be presented and discussed at the ERIDOB 2026 conference. Ultimately, this research aims to give teachers access to automated formative assessment and individualized feedback to support students' learning about evolutionary concepts.

Automated assessment of biological explanations in arabic: using reflective-prompt-engineering based prompts with genai

Hadeel Edrees Dabbah, Anat Yarden, Giora Alexandron and

Moriah Ariely

| Oral |

Keywords: *Reflective Prompt Engineering, Scientific Explanations, Automated Assessment*
Submission #: 153

Scientific explanations are central to science education; yet, students struggle to construct comprehensive, causal explanations. Providing formative feedback at scale to improve students' explanations is challenging. Bidirectional Encoder Representations from Transformers (BERT) is a transformer-based language model that shows promise in automated assessment but requires large, annotated datasets. Generative AI with Reflective Prompt Engineering (RPE) offers an efficient alternative, demonstrating success in evaluating Hebrew students' open-ended biology explanations using only a small set of scored examples. However, comparable research in Arabic is lacking. This study addresses this gap by examining whether RPE can be applied to Arabic biological explanations without requiring large, annotated datasets or dialect-specific model adaptation. We tested whether Hebrew RPE-generated prompts could effectively evaluate Arabic-written explanations. An Arabic dataset of 152 student explanations about anemia, randomly sampled from 250 responses across schools in Israel, was scored by an Arabic-speaking domain-expert using an analytic grading rubric. A second expert independently scored 25% (inter-rater reliability: Kappa 0.82 to 1.00). We tested two prompt sets: Hebrew RPE-based prompts applied directly to Arabic responses, and unsupervised ChatGPT translation into Arabic of the same prompts. Our findings indicate that RPE prompting is robust across languages, enabling accurate automated scoring of Arabic scientific explanations with prompts originally created in another language. This reduces the need for manual scoring and equips researchers and teachers with a scalable method for generating reliable formative feedback, while freeing teachers to focus on meaningful classroom interactions and pedagogical decision-making.

Between belief and curriculum: teaching evolution in a religiously diverse society

Netta Dagan, Masha Tsaushu and Tali Tal

| Poster |

Keywords: *Evolution Acceptance, Diverse Society, Teachers' Views, Religious*

Submission #: 137

Evolution is a significant yet often controversial issue in biology education, and is considered challenging to teach for a variety of reasons. Religious beliefs may influence the way it is taught. Israel's diverse education system comprises Hebrew-speakers and Arabic-speakers (mostly Jewish and Muslims), non-religious, traditional and religious. All students study the same national biology curriculum, which has mandated evolution instruction since 2016. Therefore, it is necessary to develop culturally responsive approaches to support teachers in managing the challenges they face. This study examines: (1) the extent to which biology teachers across different educational streams accept evolution, and (2) their views on evolution instruction in a religiously diverse society. Using a mixed-methods design, we administered the MATE questionnaire (Measure of the Acceptance of the Theory of Evolution) to 143 biology teachers and interviewed 28 teachers from different religious backgrounds. Findings apparently indicate high acceptance of evolution, yet significant differences emerged across educational streams, religious self-identity, and academic degree. Interviews revealed common challenges related to content knowledge and pedagogical content knowledge, and diverse approaches to discussing religious beliefs in biology lessons. This emphasizes the need for professional development that enhances teachers' knowledge, NOS understanding, and supports culturally responsive evolution instruction.

Teaching biology: tales from two contexts – a bourdieusian analysis

Rachel Davies

| Poster |

Keywords: *Biology, Socio-Economic Status, Neoliberalism, Pedagogy, Bourdieu*
Submission #: 138

High-stakes examinations, inter-school competition, and league tables characterize market-driven education systems shaped by neoliberal ideologies, which prioritize efficiency, standardization, competition, and accountability. Within such systems, education is framed as a competitive marketplace: proponents argue that market mechanisms raise standards, while critics contend they exacerbate social inequality. This study examines how market forces influence teachers' pedagogical approaches, specifically their choice and sequencing of lesson activities, when preparing Key Stage 4 (ages 14–16) students for the Biology GCSE examination in two English schools serving contrasting socio-economic communities. Concerns about the prevalence of 'teaching to the test' pedagogies, particularly in low socio-economic status (SES) schools, highlight how performative pressures can limit opportunities for meaningful learning and serve to perpetuate science attainment gaps. Despite extensive debate on performativity in English education, little empirical research has examined its impact at the classroom level in GCSE Biology. Using a multiple instrumental case study design, the two schools were selected through established Initial Teacher Education networks. Qualitative and quantitative methods explored how two biology teachers understand and implement classroom activities within their specific contexts. An abductive Bourdieusian thematic analysis, complemented by inductive reasoning, applied concepts of habitus, field, capital, doxa, and illusio to identify patterns across cases and interpret professional choices. This was supported by structured lesson observations, during which each discrete lesson activity was systematically recorded, categorized and subsequently tallied. Comparative analysis suggests that school SES shapes how the teachers negotiate exam-driven accountability. A higher SES context enables the teacher to balance intrinsic aims with selective performative practices. In contrast, in the lower SES setting, the teacher relies more heavily on exam-driven pedagogies to secure outcomes, potentially reproducing inequalities in biology teaching and student learning outcomes. Research participation also promoted habitus engagement and reflexivity, enabling a questioning and re-evaluation of established practices within the wider 'game of education'. The study offers insights for supporting teacher agency, professional development, and equity in science education under high-stakes, market-oriented policy conditions.

Systems thinking through perspectives as a solution to low coherence in biology education

Berber de Jong, Michiel Dam and Fred J.J.M. Janssen

| Oral |

Keywords: *System Thinking, Perspectives, Organizational Levels, Live Organisms*
Submission #: 209

Secondary school biology education often suffers from high complexity and low content coherence, leading to student overload. While the integration of systems thinking—an analytical approach focusing on interconnectedness across organizational levels—is a proposed solution, current models often rely on abstract systems-theoretical concepts that students struggle to connect to real biological phenomena. This study addresses this gap by focusing on perspectives (domain-specific ways of seeing and questioning, such as ecological thinking) as a concrete, domain-specific lens to promote systems thinking and increase content coherence. The primary objective of this study was to identify effective design principles (DP) for incorporating perspectives into systems thinking lessons. An experimental intervention study (N=35) was conducted, testing four DPs, including the use of a live organism (DP1) and stimulating students to ask questions at different organizational levels (DP4). Preliminary findings suggest that linking questions to perspectives across organizational levels successfully promotes systems thinking. Specifically, DP1 (live organism) and DP3 (stimulating questions) were effective, though DP2 (explaining the diagram) required more explicit teacher guidance. This research yields key design criteria for future biology lessons, emphasizing the use of a suitable live organism and showing students how to structure their perspective-based questions and answers.

Assessment in informal evolution education: a case-study

Joelyn de Lima, Despina Tsopoglou-Gkina and Penelope Papadopoulou

| Oral |

Keywords: *Non-Formal Education, Informal Education, Evolution Education, Assessment, Engagement*

Submission #: 21

Evolution education extends beyond formal education into a range of informal contexts that engage diverse audiences. Despite the widespread nature of such initiatives, such activities are seldom assessed. This paper presents a case study of embedding assessment of knowledge, engagement, and motivation in the context of an online workshop, and presents evidence for the feasibility of conducting assessments in informal online evolution education. The 2-hour online workshop targeted a diverse audience of informal educators and science communicators. Knowledge was assessed using a combination of closed-ended and open-ended questions administered before, during, and after the workshop. Engagement was assessed through connection time, response to questions, and participation in follow-up activities, while motivation was analysed from application materials. Results showed that participants possessed a baseline knowledge of evolutionary concepts but also held some common misconceptions. Post open-ended responses had more evolutionary key concepts (as compared to pre). Engagement was consistently high, with most participants attending the full session and actively participating, while continued involvement in subsequent activities demonstrated the relevance of the workshop. We found that motivation was largely driven by professional affiliation and interest in science communication. Overall, the study found that integrating assessment into informal online evolution education is both feasible and valuable. By leveraging existing instruments, assessments can be easily embedded into outreach activities to generate meaningful insights, improve design and delivery, and strengthen accountability. These findings highlight the potential for systematic evaluation to enhance the impact and adaptability of informal evolution education initiatives.

Analyzing pupils climate change “fresks” productions through a systems thinking approach

François Dessart, Isabel Pau-Custodio, Myriam

Régent-Kloeckner, Florent Figon and Catherine Bruguière

| Oral |

Keywords: *Climate Change, Systems Thinking, Secondary School, Sustainability Education, Climate Fresk*.

Submission #: 231

Climate change is a socially acute issue because of multiple interactions between humanity behaviours and the climate system. Earth’s climate system is challenged by human activities that produce greenhouse gas (GG) or reduce natural GG capture. Conversely human life conditions and social organizations are impacted directly or indirectly by climate change. As it is a complex issue, climate change education should develop key competences such as sys-tems thinking. We explore how this systems thinking approach could contribute to climate change education, during a Climate Fresk workshop in a school context. The study analyses how secondary pupils represent the causes and effects of climate change during this work-shop and create a system mapping of climate change, by exploring the links and groupings they did. Our data show that pupils (13–14-year-old) can manage some aspects of a complex system as they can conceptualize multi-causal origins or effects but struggle to embrace all the complexity, especially if they should call upon their knowledge in addition to the information written on cards.

Defining ecological literacy as a science education construct: towards conceptual coherence and operational clarity

Lars Dietrich, Roman Asshoff and Kerstin Kremer

| Poster |

Keywords: *Ecology, Literacy, Education*

Submission #: 252

The concept of ecological literacy has gained prominence in education over the past decades, yet its relationship to ecology as a scientific discipline and to models of scientific literacy remains underexplored. While ecological literacy is often framed as a desirable educational outcome, the specific scientific competencies that could anchor it within the discipline of ecology are seldom explicitly articulated. While early work on ecological literacy identified key ecological concepts, skills, and competencies, more recent educational uses of the term seldom refer back to these scientific foundations or develop them further. This project therefore investigates how ecological literacy has been defined and operationalised in educational research and how it might be conceptually reconnected to the competencies and epistemic practices of ecological science. Drawing on a scoping review of peer-reviewed publications across major educational and scientific databases, the study identifies dominant framings, contexts, and uses of the concept. These insights inform a conceptual synthesis that examines how disciplinary ecological understanding can contribute to a clearer and more consistent definition of ecological literacy. The study aims to establish a conceptually grounded and operationally transparent account of ecological literacy that supports coherent use across research and practice.

Main: culturally responsive biology education

Justin Dillon and Wilton Lodge

| Symposia | 2: Dillon: Culturally Responsive Biology Education

Keywords: *Culture, Culturally Responsive Pedagogy, Biology Education, Social Justice, Equity*

Submission #: 58

Biology is frequently presented as a neutral and universal discipline, yet many communities, particularly Indigenous and minority groups, remain marginalised within biology curricula. This exclusion constrains the breadth of scientific inquiry and perpetuates systemic inequities within education. Acknowledging the critical nature of this issue, this symposium seeks to amplify the voices of these communities, celebrate their contributions, and advocate for the meaningful integration of their cultural perspectives into biology education. Rooted in the principles of Culturally Responsive Pedagogy, culturally responsive biology education integrates students' cultural identities and lived experiences into biology teaching. This approach seeks to foster inclusivity, equity, and social responsiveness in science education. The implementation of culturally responsive pedagogies, however, encounters challenges, such as the need for teachers to cultivate critical consciousness. The three papers aim to provide a vision for reimagining biology education through a lens of cultural responsiveness. Paper 1 explores transdisciplinary approaches which integrate sensorial and aesthetic practices across sciences and arts. Paper 2 reports on a project in which students investigate climate phenomena through self-selected topics and methodologies, creating hybrid spaces where home and school knowledge systems intersect. Paper 3 argues that there is much that can school vaccine education can learn from culturally responsive pedagogy. School biology education often gives the impression that it is obvious that vaccination is a good thing. Yet a more careful consideration as to why certain groups are more likely to reject vaccination tells a different story.

Rethinking aliveness: how students apply characteristics of life across kingdoms

Benno Dünser, Ivo Ponocny and Peter Pany

| Symposia | 6: Pany: Learning to Care: Transforming Biology Education through Biodiversity Awareness

Keywords: *Living Organism, Student Conceptions, Plant Awareness, Item Response Theory*

Submission #: 131

Understanding what it means for something to be alive remains a conceptual challenge for students, who often rely on animistic and anthropocentric cues when identifying living organisms. This study examines how 824 Austrian students and 34 botanical experts associate eight canonical life characteristics with animals, plants, fungi, and bacteria, using the Living Organism Scale analysing it with the Rasch modelling. Results show that animals form a cumulative scale o life: when one characteristic (e.g., movement) is endorsed, others tend to follow. For plants, fungi, and bacteria, however, characteristics function as independent difficulty levels, indicating less integrated understanding within the groups. Growth is widely recognized in plants and fungi, while bacteria are hardest to associate with most characteristics, especially disease susceptibility. These patterns reveal distinct conceptual spaces for each kingdom and highlight persistent animistic biases. Teaching life's characteristics across multiple organism groups may support more coherent and transferable understandings of what it means to be alive. comment (Name of the symposium): Learning to Care: Transforming Biology Education through Biodiversity Awareness

Content analysis of teachers' personal and enacted pck regarding core concepts and systems thinking

Katharina Düsing, Maike Sauer, Cornelia Averdunk and

Alexander Bergmann-Gering

| Poster |

Keywords: *Systems Thinking, Core Concepts, Pck*

Submission #: 200

Systems thinking plays a central role in explaining biological phenomena and forms an essential foundation for informed participation in societal decision-making processes related to sustainable development. It enables learners to link empirical biological concepts with general properties of (biological) systems, thereby supporting deeper conceptual understanding and facilitating predictions, for example, regarding how ecosystems may change under anthropogenic influences. Educational standards in several countries embed systems thinking within cross-cutting or core concepts that highlight these system properties and provide both policy-oriented and subject-specific guidance. While recent research demonstrates that core-concept-based biology instruction can substantially enhance students' conceptual learning, studies show that only a small portion of teaching time is currently devoted to core concepts. Moreover, systematic reviews and bibliometric analyses point to a significant need for research in teacher professional development in this area. Against this backdrop, the present study investigates biology teachers' perspectives on the use of core concepts, with particular attention to their relevance for promoting systems thinking. This poster will outline key methodological steps and first results from the interview study, and will discuss implications for future research as well as for the design of teacher education and professional development.

Overcoming avoidance in teaching controversial science issues: theoretical considerations

Karoline Dütemeyer and Anna Beniermann

| Poster |

Keywords: *Controversial Science Issues, Teaching Strategies, Classroom Tension, Science Communication, Uncertainty, Scientific Media Literacy*

Submission #: 261

The Socioscientific Issues (SSI) approach aims at developing students' skills by confronting them with ill-structured, open-ended and personally relevant topics, that can be solved in dialogue and argumentation. However, not every discussion-provoking topic can be considered ill-structured or open-ended. For some topics, a scientific consensus has been reached. These topics - societally under debate, but scientifically solved - are considered Controversial Science Issues (CSI; Beniermann et al., 2021). Addressing these topics in class can be experienced as overwhelming, as the risk for classroom tension is high. Some teachers tend to use protective strategies, such as avoidance (Santos et al., 2025). With this proposal three theoretical considerations, derived from literature, will be presented as possible foundation for future solutions for teaching CSI in science classes. They include a disentanglement of science from moral, economic or political perspectives (Bromme & Goldman, 2014), an increase in knowledge on uncertainty as an inherent part of natural sciences (Lübke & Heuckmann, 2024) and recognition and regulation of the effects of cognitive biases, filters and sources of information when discussing CSI in public based on informally conveyed information in peer-to-peer social networks (Höttecke & Allchin, 2020). Further empirical investigation of these theoretical claims could be highly relevant for teachers, as effective tools would enable them to address CSI confidently in the classroom. References: Beniermann, A., Mecklenburg, L., & Upmeier Zu Belzen, A. (2021). Reasoning on Controversial Science Issues in Science Education and Science Communication. Education Sciences, 11(9), 522. Bromme, R., & Goldman, S. R. (2014). The Public's Bounded Understanding of Science. Educational Psychologist, 49(2), 59–69. Höttecke, D., & Allchin, D. (2020). Reconceptualizing nature-of-science education in the age of social media. Science Education, 104(4), 641–666. Lübke, B. & Heuckmann, B. (2024). Umgang mit Ungewissheit als Charakteristikum von Nature of Science: Eine Begriffsbestimmung und Konzeptionalisierung für die Integration in Lehr-Lern-Konzepte. In Biologiedidaktische Nature of Science-Forschung: Zukunftsweisende Praxis (pp. 59-70). Santos, P. J., Tsovaltzi, D., Osborne, J., Kolikant, Y. B. D., Salman, A., Lemmens, V., Vanhove, L., Vandecandelaere, M., Sermus, J., Hmlo-Silver, C. & Weinberger, A. (2025). Critical Education: Navigating Misinformation and Controversial Issues. In Proceedings of the 19th International Conference of the Learning Sciences-ICLS 2025, pp. 2363-2371. International Society of the Learning Sciences.

A model for reporting educational design research: insights from a case study on historic gardens

Daniel Emge and Volker Wenzel

| Oral |

Keywords*: Design-Based Research, Contextual Model Of Learning, Methodology*

Submission #: 214

Design-Based Research (DBR) is a common approach in educational sciences. It is based on iterative phases of design, evaluation and revision. This way, suitable educational concepts should be designed, and general research findings should be gained. Although several DBR-studies on non-formal biology-learning have been conducted, a general procedure for reporting their outcomes is missing. The current contribution will introduce a procedure for this purpose, aligned on the Contextual Model of Learning (CMoL). This analytic framework distinguishes three crucial contexts of free choice learning: Physical, sociocultural and personal framework conditions of the learning process. Each context is further differentiated by several factors. DBR crucially relies on a holistic analysis of different leaning environments. The CMoL may offer a meaningful framework for this purpose. We will illustrate our approach for reporting DBR-outcomes with a case study on biology-learning in historic gardens. In four design cycles, we developed a didactic concept that enables teachers to perform self-guided tours with their classes through the garden area (primary and secondary schools). In each cycle, we carried out qualita-tive interviews. The transcripts were analyzed with a coding scheme based on the CMoL that contained categories in positive and negative expressions. The percentage frequency was determined and compared for each design cycle. This approach allowed a targeted assessment of single factors. Based on two cycles, evaluations and design decisions will be discussed in detail.

Nature journaling – a method to enhance artenwissen in students

Lena Engelmann and Carolin Retzlaff-Fürst

| Poster |

Keywords: *Nature Journaling, Artenwissen, Biology Education, Biodiversity, Taxonomic Education*

Submission #: 263

The decline in species knowledge among students is a well-documented phenomenon, commonly referred to as the "erosion of species knowledge." This study investigates whether nature journaling can be an effective method for increasing students' "Artenwissen" - a framework integrating different areas of taxonomic education-, particularly in the context of insects. Nature journaling, a technique pioneered by renowned naturalists such as Alexander von Humboldt and Maria Sybilla Merian, encourages students to document their observations through drawings and written reflections. This approach has been shown to improve students' connection to nature and enhance their observational skills. However, it remains unclear whether this method can lead to a measurable increase in "Artenwissen". The research involves small group workshops, where students engage in nature journaling, focusing on insect species. The study employs a mixed-methods design, combining quantitative measures of "Artenwissen" (via a validated questionnaire) and qualitative data (gathered from student interviews and artwork). Preliminary findings suggest that students engage positively with the journaling process, overcoming initial hesitations about drawing. The study aims to explore whether nature journaling can serve as an effective tool for combating the loss of "Artenwissen" in students, an essential step in fostering a new generation of nature-conscious citizens. The results will have implications for both biology education and broader biodiversity conservation efforts.

Representations of vertebrates and invertebrates in school biology textbooks: a qualitative analysis

Sonja Enzinger-Mühlbacher and Nora Luschin-Ebengreuth

| Poster |

Keywords: *Animal Representations, Anthropocentrism, Biology Textbooks, Human–Animal Relations, Socioscientific Issues*

Submission #: 247

This project investigates how vertebrates and invertebrates are represented in Austrian lower-secondary biology textbooks and how these portrayals may shape students' conceptual and ethical understandings of animals. Textbooks play a central role in biology education, not only as sources of scientific knowledge but also as influential cultural artefacts that communicate value judgements about non-human life. Because they have long been among the most consistently used resources in students' educational experience, the representations they contain have a substantial impact on the notions of animals and nature conveyed in the classroom. Existing research has shown that animals are frequently depicted from an anthropocentric perspective. Livestock animals are often framed as resources for human use, while large vertebrates (such as pets or endangered species) tend to be portrayed in emotionally charged or protective ways. Such narrative patterns may contribute to speciesist viewpoints by highlighting animals' importance primarily in relation to human interests. In contrast, invertebrates, although ecologically crucial, often receive limited textual depth or contextualization, which may reinforce their perceived lesser significance. These representational tendencies matter, as adolescents' ethical attitudes toward animals are known to be anthropocentric, and textbook content can further shape how young people interpret and evaluate non-human life. Against this background, the project aims to analyse systematically how different animal groups are portrayed in Austrian biology textbooks, identify implicit and explicit value attributions across species, and generate empirical insights that can inform teacher education and professional development. The overarching goal is to support educators in engaging more critically with textbook content and in fostering reflective classroom discussions about human–animal relationships, ecological responsibility, and biodiversity. The study is currently in the data-collection phase. Relevant textbooks are being screened for animal-related content and will be analysed using qualitative content analysis. An inductive coding process will be used to identify key representational features, develop a category system, and compare portrayals across species. As the project is ongoing, findings are not yet available. However, preliminary results will be ready for presentation at the conference and will highlight emerging patterns in the representation of different species and the value judgements embedded in textbook narratives.

Biology and environmental awareness through an adventure-based animated series for young children

Marida Ergazaki

| Oral |

Keywords: *Informal Learning, Edutainment, Animated Cartoons, "Wild Kratts", Biology Education, Environmental Awareness*

Submission #: 47

Cartoon-based educational entertainment, or edutainment, offers promising potential for biology education and is therefore worth exploring. This study focuses on "Wild Kratts", a popular animated series created by zoologist brothers Chris and Martin Kratt. The show aims to introduce children aged 6-8 to wildlife biology and ecology in diverse habitats, as well as to some of the human-driven challenges it faces. The adventure-based animated stories feature the Kratt brothers as the main characters. Our research questions are (a) which biological concepts, and (b) which environmental messages are presented to young children through the "Wild Kratts", and how. Here, we present findings from a thematic content analysis of Season 6, a 20-episode set chosen for its accessibility and recent air date. Using NVivo software, we coded the episodes for specific biological concepts and categorized these into broader themes. Additionally, we identified the episodes' environmental messages, which we categorized thematically as well. Our findings show that the series introduces essential biological concepts in appealing ways. These cluster into thematic categories like "interaction-related" (e.g., symbiosis, adaptations), "biodiversity-related" (e.g., different species), "biological functions-related" (e.g., life cycle), and "organism distinction-related" (e.g., morphology as a classification criterion). The series encourages an environmental ethos by conveying pro-environmental messages that emphasize "celebrating" and "not exploiting/preserving" wildlife, fostering "empathy and connection" with it, drawing "inspiration" from it, and advocating harmonious "coexistence" with it in shared environments. Overall, "Wild Kratts" appears to be a rich informal educational resource whose potential to complement primary school curricula merits to be fully explored.

Analogy competence in science teacher education: validating and refining the act framework

Stina Eriksson, Karin Thörne and Niklas Gericke

| Oral |

Keywords: *Analogy, Analogy Competence, Teacher Education, Teaching With Analogies*
Submission #: 226

Analogies are widely used in science education to make abstract concepts accessible, yet they can also reinforce misconceptions if applied without pedagogical care. Despite their importance, analogy use is rarely addressed systematically in teacher education. This study validates the ACT framework (Analogy Competence for Science Teachers) as an analytical tool for assessing and supporting analogy competence in pre-service biology and science teachers. ACT defines three dimensions: conceptual, procedural, and performance competence, required for beneficial use of analogies in teaching. Data were collected in a cell biology and genetics course through a sequence of didactic assignments, including analogy analysis, micro-lesson planning, and teaching enactment. Using deductive qualitative analysis, the findings confirm ACT as a robust framework, with no contradictory evidence, while revealing the need for refinement through performance scales that capture varying achievement levels. A key insight was that insufficient subject knowledge hindered pre-service teachers' ability to select and apply analogies meaningfully, leading to an extension of ACT to include subject-matter competence as part of conceptual analogy competence. The study also highlights the importance of sequencing in teacher education: pre-service teachers benefit from first developing conceptual competence before engaging with procedural and performance aspects. These results contribute to science education by offering a validated and extended framework that supports deliberate and pedagogically sound use of analogies in teacher preparation.

Miniature landscapes. a project of art & science to approach biodiversity at initial teacher training

Marcia Eugenio-Gozalbo, Inés Ortega-Cubero, Rafael Suárez-López and Lars Dietrich

| Symposia | 6: Pany: Learning to Care: Transforming Biology Education through Biodiversity Awareness

Keywords: *Biodiversity, Initial Teacher Training, Art-Based Strategy, Nature-Based Education*

Submission #: 64

[In the Symposium: "Learning to Care: Transforming Biology Education Through Biodiversity Awareness" - Preferred strand: "Sustainability Education (including Environmental and Health Education)"] This work describes the “Miniature Landscapes” project, an interdisciplinary art and science course implemented at initial teacher training at the University of Valladolid (Spain). The main objective was promoting knowledge and appreciation of biodiversity through direct experience with nature and natural materials, and the artistic approaches of photography and drawing. Over the course of a semester, pre-service teachers worked in sustained and close engagement with a piece of soil and its living community -brought by themselves into the laboratory from a neighboring pasture- to make both scientific observations and artistic representations of it. They were requested to classify each element, and to investigate their life history, as well as to produce an artistic inventory through photography and drawing. Finally, to reflect and construct symbolic meaning on the educational experience, every group produced an artistic feature and all groups together worked on a final exhibition constituted by pictures, drawings, and models. A reflective assessment of this project was asked by means of five open-ended questions, which were qualitatively analyzed. The findings indicate that the experience was positively valued by participants, who highlighted the emotional and educational benefits of nature-based learning. It is concluded that combining art and science is an effective strategy for fostering appreciation for biodiversity and providing transferable teaching resources at initial teacher training.

Un/easy – sexuality education and the productive force of feeling uncomfortable

Rebecka Fingalsson

| Poster |

Keywords: *Didactic Objects, Inclusiveness, New Materialism, Sex Education, Queer Phenomenology*

Submission #: 148

Departing from the notion that something in sexuality education triggers unease among teachers (and students), this presentation aims to discuss how feelings, like unease, can become a productive force in developing the practice of sexuality education to achieve a more inclusive and nuanced knowledge of the body, relationships, and sexuality. In the presentation, preliminary findings and methodological insights from a collaborative effort between a researcher, teachers, and students to define the “unease” and find ways to overcome it.

Exploring plant perception in landscape images by eye-tracking

Philipp Flieger, Daniel Kaiser, Roman Asshoff, Urs M. Weber

and Lars Dietrich

| Poster |

Keywords: *Plant Awareness, Visual Attention, Plant Blindness*

Submission #: 257

Humans tend to notice animals more readily than plants, a pattern that reflects a persistent bias in visual and cognitive attention. Originally described by Wandersee and Schussler (1999) as plant blindness and later reframed by Parsley (2020) as plant awareness disparity, this phenomenon denotes the relative underrepresentation of plants in perception, cognition, and emotional engagement. Recent research has begun to explore its underlying mechanisms, identifying perception, knowledge, and attitudes as central and interrelated dimensions of plant awareness. Building on the recent findings of Dietrich et al. (2025), who investigated students' written descriptions of landscape photographs, this study examines visual attention to plants and animals directly using eye-tracking. Dietrich et al. showed that students mentioned and described animals (mammals) far more often and in greater detail than co-occurring plants, even when plants occupied salient positions in the foreground. The present study extends this line of research by exploring (i) whether eye-tracking can provide reliable process-based indicators of plant perception in complex natural scenes, (ii) how individual levels of plant awareness relate to fixation patterns, and (iii) how attention to central living objects compares to attention toward the surrounding landscape background. The study aims to link perceptual data with cognitive and attitudinal measures of plant awareness, thereby contributing to a more comprehensive, empirically grounded understanding of plant awareness disparity.

Exploring the relationship between nature connectedness and species literacy in ugandan secondary school students

Antonia Förster and Carolin Retzlaff-Fürst

| Poster |

Keywords: *Biology Education, Species Literacy, Biodiversity Learning, Nature Connectedness, Esd*

Submission #: 133

Understanding how learners develop relationships with biodiversity is a central question in biology education research. While species literacy—encompassing the ability to identify, name, and contextualize species—is considered an essential component of biological literacy, its relationship to affective dimensions such as nature connectedness remains insufficiently understood, particularly in non-Western contexts. The present study investigates how species literacy and everyday nature experiences relate to nature connectedness among secondary school students in Uganda, a country characterized by high biodiversity and culturally embedded nature contact. The research builds on Schultz's Inclusion of Nature in Self Scale (INS) and a newly designed Species Literacy Index (SLI), combining taxonomic, morphological, ecological, and context-based knowledge dimensions. A standardized questionnaire including sociodemographic variables, nature experience indicators, the INS, and plant identification tasks was administered to 220 students in Masaka District. Data analysis is currently underway. At the conference, we will present the results of correlation analyses, group comparisons, and regression models examining whether species literacy predicts nature connectedness and how nature experience and media use contribute to explaining affective dispositions toward biodiversity. The study aims to contribute to current discussions in biology education and Education for Sustainable Development (ESD) by exploring how cognitive and affective dimensions of biodiversity learning interact in a high-biodiversity, low-technification context. Implications for teaching biodiversity and designing nature-based learning environments will be discussed.

Exploring pre-service teachers' choices of sustainability topic: implications for hope and action competence

Maren Skjelstad Fredagsvik, Ragnhild Lyngved Staberg, Hilde Ervik and Vibeke Gilje Sanne

| Oral |

Keywords: *Sustainability Education, Teacher Education, Constructive Hope, Action Competence*

Submission #: 82

There is increasing recognition of the need to integrate sustainability education (SE) into curricula. In Norway, the 2020 curriculum introduced sustainability as an interdisciplinary theme across all subjects, with science combining biology, chemistry, and physics under one teacher. Teachers are central to educational change, yet pre-service teachers often feel unprepared to address sustainability, risking oversimplification of complex issues. This study investigates how pre-service teachers approach SE, with particular emphasis on fostering constructive hope and action competence. A total of 255 fourth-year pre-service teachers participated in a two-week interdisciplinary project entitled 'Visions for a Sustainable Future'. Working in groups across ten subjects, they developed teaching plans aimed at fostering agency and hope in schools. Empirical material comprises survey responses from 204 participants, including topic selections and reflections on their rationale and perceived pedagogical potential. Data was analysed inductively using qualitative content analysis. Pre-service teachers selected topics within six clusters, most frequently environmental pollution. Their choices were guided by seven forms of reasoning, with pedagogical intentions, didactic potential, and perceived importance most prominent. External inspiration and pragmatic considerations also influenced decisions. Findings suggest that pre-service teachers prioritise urgent and pedagogically feasible topics, often favouring practical activities over complex sustainability issues. While this reflects a commitment to fostering agency and constructive hope, it may limit opportunities for pluralistic perspectives and critical reflection. The study underscores the need for teacher education to provide structured opportunities to explore diverse sustainability topics and strengthen competencies for action-oriented, pluralistic teaching that empowers students to envision sustainable futures.

Conceptual change videos and texts - a comparison of the effectiveness of students' concept formation

Vanessa Freemann and Anna Beniermann

| Poster |

Keywords: *Conceptual Change, Students' Conceptions, Digital Media, Teaching Strategies*
Submission #: 265

Following the long-standing emphasis in science education research on students' naive conceptions, the use of Conceptual Change Texts (CCTs) as a pedagogical approach remains mainly unquestioned as they have proven to be effective. However, CCTs have been found to be ineffective for students with reading difficulties and limited content knowledge. These issues can generally be addressed through the use of videos, which highlights the need for Conceptual Change Videos (CCVs). The aim of this study is therefore to evaluate the impact of CCVs on students' conceptual change and comparing the outcomes with those of traditional CCTs. To this end, a mixed-methods design is employed to measure students' concepts before and after they receive CCVs or CCTs as part of their science lessons. Additionally, reading comprehension, cognitive load and content knowledge are assessed to ascertain the factors that influence the efficacy of both methods. The findings could consequently serve as a catalyst for new research about how naive conceptions are approached in science education. The potential applications of this research extend beyond academia to science teaching in schools. Firstly, the findings could equip educators with a new tool to make their teaching practices more diverse, digital and effective. Secondly, the study will result in ready-to-use teaching materials being created.

Three levels of challenges teacher educators encounter by integrating education outside the classroom

Iva Frýzová and Natálie Čeplová

| Oral |

Keywords: *Biology Education Outside The Classroom, Primary Teacher Education, University Educator*

Submission #: 213

Through semi-structured interviews, the present study explored university educators' challenges in integrating education outside the classroom within biology teaching courses in university study programmes for primary school teachers. Educators from six universities in the Czech Republic answered an interview about their experiences with science teaching courses for pre-service teachers. Qualitative thematic analysis of data identified three levels of challenges educators encounter. The regional level presents the region's potential and the availability of suitable settings for teaching. The university level presents the structure of study programmes and material and organisational support from the university to science teaching courses. The personal level, in turn, represents educators' beliefs and professional history and the opportunities for cooperation in science education outside the classroom. The analysis indicates that regional and university-level challenges impact the availability of opportunities to learn and teach science outside the classroom. In contrast, personal-level challenges affect the quality of these opportunities for pre-service teachers in science teaching courses.

Passed the test? competence assessment in german biology abitur tasks

Maja Funke, René Leubecher and Jörg Zabel

| Poster |

Keywords: *Abitur Tasks, Competence Assessment, Scientific Literacy*
Submission #: 37

Twenty years after the introduction of national educational standards for Biology in Germany, it remains unclear to what extent the competencies defined in these standards have already been implemented in Abitur tasks. The standards aim to foster students' scientific literacy and define four competence areas: content knowledge (Sachkompetenz, SK), scientific inquiry/epistemic knowledge (Erkenntnisgewinnungskompetenz, EK), subject-specific communication (Kommunikationskompetenz, KK), and decision-making and bioethical reasoning (Bewertungskompetenz, BK). Since examination tasks play an important steering role in educational reform processes, analyzing their design is essential – particularly as nationwide standardized Abitur examinations aligned explicitly with these standards will be introduced from 2025 onward. This study examined 949 tasks from written Biology Abitur examinations administered between 2016 and 2024 in four German federal states using qualitative content analysis. Findings indicate that the Abitur tasks predominantly targeted SK and KK, whereas EK and especially BK were addressed much less frequently. These proportions remained largely stable across the nine-year period, though notable differences between federal states emerged, particularly concerning EK and KK. Overall, the steering function of examination tasks appears to have been used only to a limited extent for implementing certain competencies, especially in the areas of EK and BK. These skills in particular play an important role in the context of scientific literacy. To better address scientific literacy in exams and to emphasize its relevance for biology teaching, future Abitur examinations should more strongly integrate tasks targeting EK and BK.

The experiment design toolbox: a novel task format for assessing competencies in planning experiments

Thomas Gabor, Katharina Düsing and Ute Harms

| Oral |

Keywords: *Planning Experiments, Control-Of-Variables Strategy, Scientific Inquiry, Asssessment, Instrument Development*

Submission #: 43

Scientific reasoning competence has long been a central objective of science education enabling students to critically evaluate scientific processes and evidence and to participate responsibly in societal discourse. Within scientific reasoning, planning experiments represents a key subcompetence closely linked to understanding the requirements for experiments to allow for causal inference, as described by the Control-of-Variables Strategy (CVS). To address limitations of existing open-ended and multiple-choice assessments, this study developed and evaluated a novel semi-open digital task format—the Experiment Design Toolbox—which simulates decisions in planning an experiment, enabling valid and efficient assessment of planning experiments. The Toolbox was tested with 169 German secondary school students (grades 8–9), who completed Toolbox tasks and multiple-choice tasks as well as open-ended tasks as reference formats, each in two levels of complexity. By correlation analysis and bootstrapping processed we compared Toolbox and multiple-choice task results in regard to competence aspects, competence levels and CVS design errors and found moderate to strong associations between open-ended and Toolbox tasks (Kendall's Tau = .25–.39; Cramer's V = .32), consistently and significantly exceeding those between open-ended and multiple-choice tasks. Only CVS design errors in high-complexity tasks showed nonsignificant associations. Findings support the validity of the Toolbox task format for assessing students' competencies in planning experiments. By requiring active application of CVS principles, it captures deeper reasoning processes than MC items and offers automated evaluation for formative and summative assessment in digital learning environments.

Holistic education through hackathon: enhancing 21st-century skills among fifth graders - a case study

Adiv Gal and Dana Sachyani

| Oral |

Keywords: *Hackathon, Elementary Education, Holistic Education, 21St-Century Skills, Sustainability*

Submission #: 7

This study explores the potential of hackathons as a pedagogical tool for promoting 21st-century skills in elementary education. Conducted in a rural school in northern Israel, the research involved fifth-grade students who had been engaged for years in a science program centered on the conservation of the Lesser Kestrel, a local bird species threatened by the invasive Common Myna. In response to the ethical and ecological complexities arising from the conflict between these species, the school integrated a hackathon into its curriculum, aiming to combine scientific, technological, and humanistic perspectives according to ecohumanism principals. Adopting a qualitative case study design, the research utilized three complementary tools: students' drawings with accompanying explanations, open-ended questionnaires, and focus groups. Data analysis followed a deductive approach, coding responses according to established frameworks of 21st-century skills (creativity, critical thinking, communication, collaboration, information literacy, and life and career skills). Findings show that the hackathon environment significantly enhanced students' abilities across all categories. The process fostered creativity and innovation by motivating students to develop practical and humane solutions, strengthened critical thinking by integrating ethical reasoning with ecological considerations, and advanced collaboration and communication through teamwork with peers and external experts. Students also demonstrated growth in digital literacy, adaptability, and leadership, reflecting the holistic impact of the activity. The study concludes that hackathons can serve as powerful vehicles for holistic science education in elementary schools, preparing young learners to address complex, real-world challenges by integrating cognitive, social, ethical, and technological dimensions into their learning.

Flebocollect: school citizen science to study leishmaniosis disease authors and affiliation

Rosa Gálvez, Ángela Bermejo and Ana I. Mora-Urda

| Symposia | 1: Tsybulsky: Transforming Biology and Environmental Education through Citizen Science

Keywords: *Citizen Science, Stem Education, Leishmaniosis*

Submission #: 46

Citizen science is increasingly recognized as a powerful tool for both scientific research and science education. The Flebocollect project exemplifies this approach by engaging school students in the study of leishmaniosis—a neglected vector-borne disease—through game-based learning and hands-on activities. Originating in Madrid, Spain, Flebocollect integrates STEM education to promote a One health approach. The project's educational sequence includes 1) the board game "Outbreak," which simulates a real and nearby outbreak scenario, 2) the construction and deployment of do-it-yourself (DIY) light traps for capturing phlebotomine sand flies, the vectors of leishmaniosis, contributing via a mobile phone application to a national sand fly distribution map, and 3) creative activities such as infographic contests. More than 1,800 students from 20 schools across Spain participated in this educational initiative that raised their awareness of the impact of ecosystem disruption on global health, while actively contributing to the prevention of future leishmaniosis outbreaks. Survey results from 841 students revealed substantial improvements in scientific literacy, motivation, and willingness to engage in future citizen science projects. Notably, 82% of participants reported increased awareness of the concept of citizen science after completing the project, and nearly 78% expressed interest in participating in similar initiatives in the future. The project also fostered a sense of scientific contribution and empowerment among students, with high ratings over 10 for both the board game (8.66) and the DIY trap workshops (8.78). Flebocollect's experience offers valuable insights for scaling similar initiatives internationally, particularly in regions facing neglected vector-borne diseases like leishmaniosis.

Rethinking biodiversity education: early insights from a nationwide teacher training initiative

Carola Garrecht, Barbara Jaun-Holderegger, Eric Wyss, Ueli Studhalter and Sebastian Tempelmann

| Poster |

Keywords: *Biodiversity Education, Teacher Education, Sustainability Education*
Submission #: 67

A rich and intact biodiversity is essential for human survival and well-being and yet, biodiversity is declining at an alarming rate. Research shows that both students and pre-service teachers often lack a solid understanding of biodiversity and its importance. This raises important questions about how well teachers are prepared to address biodiversity-related content in the classroom and how systematic teacher training might influence their ability to promote meaningful learning experiences for students. This four-year project aims to initiate a shift in how biodiversity education is approached within Swiss teacher training and thus also in compulsory schools. It pursues three core objectives: (i) the development of competency frameworks for biodiversity education in both teacher training and compulsory schooling, (ii) the design of teacher training concepts alongside learning materials tailored to different educational levels, and (iii) the acquisition of scientific insights into the impacts of biodiversity education on knowledge, attitudes, and intended behaviours of teachers and students. To assess the effectiveness of the teacher training and the learning materials, a controlled pre-post-follow-up study will be conducted. In collaboration with several Universities of Teacher Education across Switzerland, data will be collected using a range of assessment instruments, with participation expected from over 500 pre-service teachers and approximately 1000 students at all stages of compulsory education. The poster presents conceptual foundations and the methodological design of this project and offers a first insight into a nationwide teacher training initiative to strengthen biodiversity education.

From descriptive to predictive biology - exploration of k12-students' data literacy in biology education

Tim Göddenhenrich and Benedikt Heuckmann

| Oral |

Keywords: *Big Data, Data-Driven Science, K-12 Education, Mathematical Biology, Health*
Submission #: 152

The increasing datafication has resulted in Data Literacy becoming a 21st century skill that is essential to participate in society. Consequently, it must be promoted in K-12 education. However, the question remains as to what role does biology education play in fostering Data Literacy? In previous research, it is evident that K-12 students already work with data in biology-related contexts, but predominantly in a descriptive way using paper and pencil, for example in experiments. But, given the existence of stored data in repositories, it has been possible to engage in professional science and change biology education to a predictive science subject. In accordance with a design-based-research approach consisting of three pillars, a teaching model for upper secondary level in health-related research is being developed. The model comprises data about reported cases of tick-borne encephalitis and various abiotic factors. We use the Data Literacy framework by Schüller et al. (2019), because it is a very complex construct to focus on specific sub-skills when promoting Data Literacy. Data Literacy is increasingly recognized as an important component of science education and current literature emphasizes that biology education primarily promotes competencies in evaluating data, interpreting results, interpreting data and deriving actions. The aim of this contribution is to provide an overview on the role of biology education in fostering Data Literacy in K-12 education according to recent literature and this perspective will be empirically enriched by derived challenges students face when working with real, complex, and authentic data.

Future teachers' perceptions on their hability to work on food education in classroom

Cristina Gil Gonzalez and Beatriz Bravo Torija

| Poster |

Keywords: *Perceptions, Teachers, Food, Training, Primary Education*

Submission #: 101

The lack of knowledge among both practicing and future teachers regarding what and how to teach about nutrition makes delivering nutrition education in the classroom a complex task. The current Primary Education Teaching Degree program contributes to this situation, as future teachers do not take any subject related to this topic (Cubero et al., 2011). To determine whether this limitation is recognized by future teachers, as well as its consequences for their professional practice, this study aims to identify the perceptions that future teachers of Primary Education Teaching Degree (blind) have about their ability to work on food education in their classrooms, considering their limitations and training needs. To this end, a survey with 11 questions was developed and administered, addressing the dimensions of the "Pedagogical Content Knowledge" (PCK) construct. The results obtained reveal that future teachers lack basic training on what and how to teach about food, as they are unfamiliar with fundamental concepts for achieving adequate nutritional competence (such as nutrients and labeling, among others), and they barely identify effective assessment and instructional tools. Therefore, it is necessary to include food subjects in the Primary Education Teaching Degree program to improve the knowledge and eating habits of future teachers.

Biology teachers' curricular knowledge. minding the gap between official and implemented curriculum?

Leroy Großmann and Bianca Reinisch

| Oral |

Keywords: *Pck, Curriculum, In-Service Biology Teachers*

Submission #: 113

Teachers' pedagogical content knowledge (PCK) shapes how curricular expectations are translated into classroom practice. Within PCK, curricular knowledge – teachers' understanding and use of standards, syllabi and framework documents – is crucial for transforming disciplinary content into teachable and learnable forms. While national educational standards define competency-based biology teaching in Germany, previous research suggests that teachers privilege more practice-proximal materials and often plan in a content-oriented way, raising questions about how competency expectations are interpreted and enacted in everyday instruction. This study investigates in-service biology teachers' acceptance and use of different curriculum documents (national standards, regional framework curricula, school-based curricula) in lesson planning and how this reflects their curricular PCK. A questionnaire, developed from established instruments in science and mathematics education and refined through expert review, was administered anonymously to 98 in-service biology teachers from two German federal states. It includes demographic and professional background variables, items on attitudes towards standards, frequency of use of different curriculum documents, and scales assessing both the perceived importance and the self-reported promotion of the four competency areas (including bioethical competence) specified in current German curricula. Closed-format items were analysed using descriptive and inferential statistics; open responses were examined via structured qualitative content analysis. Results indicate that teachers rely more on state-specific and school-based curricula than on national standards, implying that the official national curriculum influences classroom practice only indirectly. Teachers report a strong focus on content-related standards, whereas process-related competencies such as inquiry, communication, and especially bioethical competence are addressed less frequently. Although all competency areas are rated as important, their implementation is selective, and teachers express uncertainty about how to operationalize process-related and bioethical competencies in realistic lesson structures. These findings point to gaps in teachers' curricular PCK and highlight tensions between competency-based curricular expectations and planning practices. They underline the need for targeted professional development that supports teachers in interpreting standards and designing competency-oriented biology instruction.

Using video-based science outreach to support the teaching and learning of complex epigenetic concepts

Cecília Guerra, Zé Loureiro, David Oliveira and Joana Pereira

| Poster |

Keywords: *Epigenetics, Design-Based Research Methodology, Video*
Submission #: 146

Epigenetics is transforming our understanding of inheritance by revealing how environmental factors can modulate gene expression and shape phenotypic diversity without altering DNA sequences. Within the Extended Evolutionary Synthesis, epigenetic mechanisms are recognized as key non-genetic contributors to adaptation and evolution. Despite increasing public interest, understanding of epigenetics is limited, and misconceptions—such as deterministic views of genetics—remain widespread. The EPIBOOST project ("BOOSting excellence in environmental EPIgenetics") addresses this challenge by investigating environmentally induced epigenetic changes in aquatic organisms and translating complex concepts into accessible educational resources through a three-video series. A multidisciplinary team of biologists, educators, and designers developed the videos using a design-based research methodology integrated with design thinking principles. The iterative production process included literature review, identification of common learning difficulties, collaborative storyboarding and scriptwriting, visual and audio production, editing, expert feedback, and iterative testing with target audiences. Each video targets specific learning goals: Video 1 – What Is Epigenetics? introduces DNA methylation, gene expression, and phenotypic variation to build awareness; Video 2 – How Epigenetics Meets Evolution explores epigenetic inheritance, phenotypic plasticity, and the interplay between environment and evolution, fostering interest and critical reflection; Video 3 – Epigenetics and the Environment highlights ecological applications, including contaminant-induced epigenetic changes, promoting understanding, enjoyment, and societal relevance. The AEIOU framework (Awareness, Enjoyment, Interest, Opinions, Understanding) guided both narrative and visual strategies to ensure clarity, engagement, and conceptual accessibility. By combining interdisciplinary expertise, iterative design, and structured science communication, the EPIBOOST video series demonstrates an effective model for translating emerging scientific knowledge into meaningful educational tools. The series supports public epigenetic literacy, corrects misconceptions, and connects molecular and ecological processes to real-world environmental challenges, providing a valuable resource for both formal and informal science education.

Systems thinking in sustainability education: change over time in the “space junk” scenario

Zeynep Güler and Burcu Güngör Cabbar

| Oral |

Keywords: *Sustainability Education, Systems Thinking, Pre-Service Teachers, Scenario-Based Instruction, Behavior Over Time Graph*

Submission #: 160

This study examines pre-service teachers' competency in analyzing complex environmental problems using a “Space Junk” scenario designed with a systems thinking approach. The instructional design utilized Behavior Over Time Graphs (BOTGs) to address the dynamic structure of space debris. The research employed a qualitative case study design with 22 pre-service teachers from various disciplines in Turkey. Data were collected via scenario-based worksheets and evaluated using content analysis. Results indicate that participants successfully defined system elements and basic causal relationships. However, they demonstrated limitations in interpreting BOTGs, explaining trends through cause-and-effect frameworks, and proposing long-term sustainable solutions. The study concludes that scenario-based systems thinking applications support multi-dimensional analysis skills and advocates for their integration into teacher education.

Evaluating an international summer school on nature-based solutions in science teacher education

Maximilian Haberbosch, Kim Oun, Johanna Nagl, Lucas Weinberg and Suzanne Kapelari

| Oral |

Keywords: *Nature-Based Solutions, Environmental Education, Futures-Oriented Science Education, Science Teacher Education*

Submission #: 217

Nature-based Solutions (NBS) are increasingly highlighted in European policy as interventions that work with ecological processes to address societal challenges, yet they remain only marginally addressed in school curricula and teacher education. In contrast, frameworks for Education for Sustainable Development (ESD) emphasise competence-oriented learning and call for teachers who can design learning environments that connect ecological and social dimensions of sustainability. This study examines how an international Summer School on NBS can support science teachers' professional learning within this ESD-oriented perspective. The Summer School brought together pre- and in-service teachers from six European countries for a one-week programme that combined input on NBS, field visits to local NBS sites and collaborative design of NBS-related teaching activities. A pre–post evaluation design was used, based on an online questionnaire and pre–post semi-structured interviews. The questionnaire captured demographic data, familiarity and knowledge regarding NBS, self-assessed competences to integrate NBS into teaching, perceived relevance of selected sustainability competences and open responses on learning outcomes, challenges and transfer ideas. Interviews focused on expectations, learning experiences and intentions for classroom implementation. The evaluation focuses on four dimensions of professional learning: knowledge gain, competence development, perceived relevance and transfer potential, guided by the research question: How does participation in an international Summer School support science teachers' professional learning on Nature-based Solutions? Preliminary results from the questionnaire data indicate clear knowledge gains, with participants reporting higher familiarity with NBS and providing more accurate and differentiated descriptions after the Summer School. Participants also report increased confidence in planning NBS-related lessons, using local NBS as learning environments and assessing related learning outcomes. NBS-related competences such as systems thinking, collaboration and outdoor learning are rated as highly relevant for science teaching, and participants articulate concrete ideas for integrating NBS into their practice, alongside anticipated structural constraints such as limited curriculum time and infrastructure. The ongoing qualitative analysis of interview data will be used to deepen these findings. Overall, the study provides initial evidence that an NBS-focused, ESD-informed Summer School can effectively support sustainability-related professional learning in science teacher education.

Epistemic emotions as markers and mechanisms in ssi learning through digital curation

Remah Haj and Dina Tsybulsky

| Oral |

Keywords: *Socio-Scientific Issues, Digital Curation, Epistemic Emotions, Ssi-Tl Framework, Learning Processes*

Submission #: 9

Socio-Scientific Issues Teaching and Learning (SSI-TL) has emerged as a powerful framework for advancing scientific literacy and civic engagement. While research demonstrates its educational value, classroom enactment remains limited by the lack of pedagogical tools addressing both the scientific and social complexity of SSI. To bridge this gap, the SSI-TL framework has been expanded through the SSI-DC pathway, which incorporates Digital Curation as a pedagogical practice. SSI-DC enables students to curate, critique, and circulate digital resources, providing opportunities for meaningful learning that integrates multiple perspectives and fosters evidence-based positions on SSI. This study investigates the underexamined role of epistemic emotions in the SSI-DC pathway, conceptualizing them as both markers and mechanisms of learning processes. The research employed a qualitative single-case study in a 10th-grade biology classroom in Israel (n = 35). Data were collected from reflective reports, semi-structured interviews, and video recordings of classroom discourse, and analyzed through a combined deductive–inductive approach. Findings reveal a clear transformation: initial negative emotions (confusion, frustration, anxiety) marked students' struggles with moral complexity and new pedagogical demands, but gradually shifted toward positive emotions (curiosity, enjoyment, surprise). These emotions not only signaled progression but also functioned as mechanisms that deepened understanding, strengthened collaboration, and fostered agency. The study extends the SSI-TL framework by demonstrating how the SSI-DC pathway leverages epistemic emotions as resources for meaningful learning.

Extinction of experience? to what extent do secondary school students (age 10-18) have personally relevant nature experiences?

Marcus Hammann, Sören Werner and Helener Kesseler

| Oral |

Keywords: *Nature Connectedness, Extinction Of Expereince, Persoanl Relevance*
Submission #: 141

In light of the extinction of experience, there is a growing focus of research on the role of direct experiences of nature and their perceived personal significance among young people. This study investigates individual experiences of nature among secondary school students from the perspective of their perceived personal significance. To this end, students aged 10 to 18 (N = 814) were asked to describe a specific moment in nature that they remember well, rate its perceived personal significance and its frequency. In addition, the students were asked how often they experience nature in general and how significant they find these experiences. The extent of their connection to nature was also determined. The aim of this study is to determine the significance students attribute to their personal experiences of nature and the factors associated with their perceived personal significance. The main findings of this study are that age, gender, external aspects (such as the distance of the location) and internal aspects (such as emotions) are crucial for the perceived personal relevance of nature experiences. Significant associations were found between the frequency and significance of specific nature experiences and nature visits in general, supporting the assumption that students who perceive their own nature experiences as personally meaningful are likely to want to experience them again. Students' connection to nature correlates with both the frequency and significance of nature visits, indicating a link between personal connection to nature and the perception of nature experiences. The majority of students attach great importance to personal nature experiences and advocate for nature experience opportunities in biology lessons.

Climate change education in austria's teacher education for secondary schools

Linda Hämmerle, Ella Guelmino and Eva Fraňková

| Poster |

Keywords: *Climate Change Education, Higher Education, Curriculum Analysis, University Education, Teacher Education*

Submission #: 191

Higher education institutions (HEIs) play a central role in preparing students to understand and address climate change, yet the integration of climate change education (CCE) in higher education remains limited across European universities. Research indicates that insufficient knowledge combined with climate-related anxiety can hinder students' capacity to act. In teacher education, this challenge is particularly significant: teachers are key actors in enabling long-term societal transformation, and comprehensive preparation of pre-service teachers is essential for achieving broader climate goals. Yet, it remains unclear to what extent Austrian teacher education institutions address CCE strategically and pedagogically – including its scientific, socio-political, emotional, and ethical dimensions. This study investigates how CCE is conceptualized and implemented across Austrian secondary teacher education programs. The key research questions are: (1) To what extent is CCE integrated into university strategies, curricula, and selected courses? (2) Where it is present, how is CCE contextualized, what aspects are included, and which CCE-relevant competencies are targeted? We apply a multi-level document analysis across Austria's four regional teacher education clusters. Strategy documents and curricula are examined using keyword analysis, while course-level analysis at the University of Vienna uses qualitative content analysis. The study provides an overview of current CCE in Austrian secondary teacher education programs, identifies gaps between policy and practice, and highlights innovative approaches and needs for strengthening climate-related competencies in pre-service teacher education.

Main: advancing evolution learning – novel conceptual and methodological approaches to evolution education

Ute Harms

| Symposia | 4: Harms: Advancing Evolution Learning – Novel Conceptual and Methodological Approaches to Evolution Education

Keywords: *Ai-Based Methodologies, Assessment, Conceptual Change, Evolution Education, Repertory Grid Method*

Submission #: 89

This symposium addresses a persistent challenge in biology education: effectively teaching evolution. The understanding of the biological evolution by students and even (prospective) teachers remains hampered by misconceptions, particularly regarding core concepts such as adaptation, ancestry, and fitness. Hence, the aim of the symposium is to bring together and to discuss the findings from studies conducted in four different countries that investigated novel approaches to evolution education, leveraging data analysis, artificial intelligence, and qualitative methods to provide innovative solutions. The symposium will focus on three interconnected themes: the impact of learning with data and patterns, utilizing AI to assess student understanding, and exploring the conceptual frameworks through which teachers themselves understand evolution. The papers presented will showcase the application of new, especially AI-based methodologies for evolution education and even beyond. Also, it will address three dimensions of evolution education: (i) students, (ii) prospective teachers, and (iii) resources that are relevant for teacher education. Study 1 informs our understanding of how data, graphs, and patterns impact student reasoning. This work, alongside study's 2 use of machine learning to analyze student claim-evidence-reasoning explanations, highlights the need for more sophisticated assessment tools. Study 2 along with study 3, demonstrate the value of AI-driven formative assessment for identifying and addressing student conceptual gaps in evolution understanding. Furthermore, study 4 offers crucial insight into the foundational understanding of the key concept adaptation held by pre-service teachers applying the repertory grid method. These analyses, coupled with study 5, which uses a chatbot to reveal teacher judgment accuracy and potential learning difficulties in evolutionary key concepts, demonstrate the potential for technology to not only diagnose student challenges but also to reveal unrecognized gaps in understanding evolution on the side of prospective biology teachers. Finally, the comparative analyses of "ancestry" and "adaptation" using text mining combined with the application of Large Language Models ("studies 6 and 7) underscores the importance of tracking the shifts of conceptual frameworks within scientific literature regarding evolutionary key concepts, informing the development of more nuanced and robust teaching materials. Ultimately our symposium will aim to provide a glimpse into the future of

evolutionary education (research), highlighting the critical role of technology in transforming our ability to understand and support students and (prospective) teachers in understanding evolution.

Multispecies storytelling for transformative biology education in urban schools

Neil Hart-Camus

| Poster |

Keywords: *Multispecies Storytelling, Post-Colonial Ecology, Urban Environmental Education, Relational Pedagogy, Diasporic Youth*

Submission #: 274

England's environmental education, through a curriculum informed by neoliberal ideologies, does not do enough to engage London's majority diasporic learners. Socially-critical themes that could engage these learners are marginalised, and opportunities to develop deep rooted and meaningful relationships with their local ecology, that entangles their history into the environment, are limited. This research investigates the development of meaningful relationships with the more-than-human in urban space through multispecies storytelling. London's uniquely diverse human population and urban ecology share histories of urbanism, colonialism, migration (Barua, 2022). This provides a unique opportunity to explore socially-critical relationships to urban place through the discovery of shared lived experiences with the urban species with whom young Londoners are entangled. The study investigates practices of attentive perception as an approach that can build relationality (van Dooren et al., 2016). Storytelling as a pedagogical strategy is currently under-used in the secondary science classroom (Rowcliffe, 2004). Stories are inherently collaborative and relational (Verlie, 2021). I introduce the term multispecies storytelling to describe the process of developing and sharing stories that talk of an entangled multispecies experience of life in urban space. The research aims to investigate the potential of storytelling to act as a pedagogical and research approach to engage young Londoners with the city's post-colonial ecologies. This is developed through the extent to which storytelling can inform relationships with urban space in young Londoners, and how effective storytelling is as a method to bring the voice of young people, personal and family histories and relationships to urban nature, into environmental and biology education in schooling. These will be investigated through photo-walks (Pyryy, 2016), which will encourage attentive perception with the species that young Londoners share urban space with. They will select an urban species that lives wild in the city, and will hear elements of its social, historical and political story. This will act as a prompt for the participant on their walk. This will be followed by semi-structured interviews and narrative enquiries where participants will share the story of their walk and of their engagement with the companion species. Stories will be developed to produce a multispecies story in collaboration with those of other participants and other companion species. Pilot data suggests the approach changes the way young people engage with urban space and urban nature, and builds relationality through focusing on shared experiences.

Together for insects? fostering students' agency for insect conservation through collective action

Laura Härter and Jörg Prof. Dr. Zabel

| Oral |

Keywords: *Pro-Environmental Agency, Insect Conservation, Collective And Self-Efficacy*
Submission #: 76

The global biodiversity crisis is reflected in severe declines in insect populations, threatening ecosystems and human well-being. In response, the PISA 2025 Science Framework emphasises the development of pro-environmental agency, highlighting dispositions such as knowledge, self- and collective efficacy, willingness to act, and identity. To explain how these dispositions interact, this study draws on the Social Identity Model of Pro-Environmental Action (SIMPEA), which describes how social identity and collective efficacy jointly underpin pro-environmental action. Integrated causal models further highlight self-efficacy as a key predictor. The Action Competence for Insect Conservation (ACIC) framework operationalises PISA's dispositions for school contexts by defining knowledge, confidence, and willingness to act as core components of insect conservation agency. ACIC thereby provides a pedagogical structure for promoting students' action competence in science education. This study investigates whether collective insect conservation measures in secondary science education strengthen action-related variables at individual and collective levels, with the broader aim of fostering pro-environmental action beyond school. A quasi-experimental design with Grade 9 students (n = 44) compared an intervention group engaging in collaborative insect conservation activities – including creating an insect-friendly meadow and participating in the citizen science project VielFalterGarten – with a control group receiving regular instruction. Questionnaire data (pre/post/follow-up) and follow-up interviews were collected. Findings show significant increases in knowledge, confidence, and self-efficacy in the intervention group, while collective efficacy showed no significant change. Interview data suggest that students perceived the school garden project as a tangible conservation contribution and part of a wider collective effort.

Black-boxes recognition as a crucial step in the process of mechanistic reasoning

Michal Haskel-Ittah and Shanny Mishal-Morgenstern

| Symposia | 3: Morgenstern: Mechanistic reasoning in biology: Exploring processes, challenges, and educational Value

Keywords: *Scientific Thinking, Mechanistic Reasoning, Explanations*

Submission #: 71

Mechanistic reasoning is central to biological explanation, yet learners often overlook unobservable entities or misunderstand how causes is linked to effects. This study positions black-box recognition, the identification of missing mechanistic components within explanations, as a crucial step in mechanistic reasoning. Explanatory black boxes are not mere omissions but functional gaps that shape explanations and signal points for inquiry. Despite their importance in science, students and teachers rarely recognize such gaps, especially in seemingly coherent yet mechanistically shallow explanations like those generated by artificial intelligence (AI). This study examined how high school students identify explanatory black boxes while constructing mechanistic explanations with an untrained version of ChatGPT-5. Two pairs of tenth-grade students (one male, one female) explained biological phenomena, one genetic (Hemophilia A or Sickle-Cell Anemia) and one ecological, through AI-supported dialogue. They were prompted to locate black boxes, decide whether unpacking was necessary, and, if so, use AI for elaboration. Two strategies emerged: (1) testing logical consistency, where students exposed gaps by probing contradictions in causal reasoning; and (2) questioning transitions between process stages, noticing missing connections across phenomena. However, recognition was hindered when students fixated on unfamiliar terminology, disagreed on the existence of gaps, or relied on heuristic reasoning. Findings suggest that recognizing black boxes is a pivotal yet challenging precursor to deep mechanistic reasoning in biology: when gaps went unnoticed, inquiry ceased. Pedagogically, biology teachers can build on students' intuitive strategies to transform black boxes from unnoticed components into productive sites for mechanistic inquiry.

Main: mechanistic reasoning in biology: exploring processes, challenges, and educational value

Michal Haskel-Ittah, Shanny Mishal-Morgenstern, Kostas Kampourakis, Julia Svoboda, Sugat Dabholkar,

Scott Benjamin, Marina Orth and Benedikt Heuckmann

| Symposia | 3: Morgenstern: Mechanistic reasoning in biology: Exploring processes, challenges, and educational Value

Keywords: *Mechanistic Reasoning, Genetics Education, Evolution Education, Health Education, Models*

Submission #: 91

In the past decade, increasing attention has been given to mechanistic reasoning in educational standards and in science education research. Such explanations are used by scientists to describe, explain, and control phenomena, and recent evidence suggests that they may also enhance people's reasoning in everyday contexts. In biology, mechanisms operate across multiple levels, from the molecular to the population level, involve feedback loops, emergent processes, and include observable and unobservable entities. Additionally, since all biological entities are products of evolutionary processes, a fine line exists between mechanistic reasoning and teleological reasoning, which attributes phenomena to need-based or goal-directed causes. This distinction is often difficult for students to grasp and challenging for educators to detect in students' explanations. Consequently, reasoning about mechanisms and constructing mechanistic explanations in biology is a complex task. This proposed symposium will present four studies that address mechanistic reasoning from complementary perspectives: 1.The integration of mechanistic understandings – The first study will present a microgenetic analysis of a college student's evolving mechanistic explanations in the context of evolution. It will trace a student's movement between individual-level and population-level explanations, shedding light on how complex mechanistic understanding develops over time. It will illustrate how mechanisms that appear to feature intentional change by organisms can be integrated with population-level mechanisms. 2. Scaffolding mechanistic explanations – The second study focuses on instructional scaffolds designed to support middle-school students in constructing mechanistic explanations of photosynthesis. Specifically, it will illustrate how using a software for coding the mechanism helps them engage more deeply with molecular-level processes. 3. Black boxes as engines of refinement – The third presentation will examine the role of explanatory "black boxes", points within explanations where the mechanism is unspecified. These black boxes can serve as cognitive markers that trigger further inquiry. The study will analyze how 10th-grade students identify and use black boxes in ecological and genetic contexts, their challenges and how black-boxes catalysts the refining of their explanations. 4. The value of mechanistic understanding – The final study will explore the

implications of mechanistic understanding in health-related contexts. By comparing the causal versus mechanistic understanding of foodborne illness among 11 graders the study provides indications for an effect of these types of knowledge on individuals' risk perceptions. Collectively, the studies in this symposium aim to advance our understanding of how mechanistic reasoning in biology develops, how it can be supported, and why it matters.

Pre-service teachers and diversity-sensitive biology education: perceptions and challenges

Sara Hassunah and Arne Dittmer

| Oral |

Keywords: *Teacher Education, Diversity-Sensitive Education, (Self-)Reflexivity*
Submission #: 118

As public debates around diversity grow increasingly polarised, biology education is challenged to respond in ways that promote equity, critical reflection and democratic participation. This project investigates how pre-service biology teachers perceive the value, responsibility, and challenges of implementing diversity-sensitive biology education, and how teacher education can better support them in this task. Drawing on frameworks such as Inclusion, Scientific Literacy, Science Capital, Nature of Science for Social Justice and Nature of Bioscience and adapting a (self-)critical, (self-)reflexive approach, the project positions biology education as uniquely suited to engaging with ethical, socio-cultural and political dimensions of diversity. Recognising teachers as pivotal actors in shaping learning environments, the project examines how the assumptions and uncertainties of future teachers shape their readiness to address diversity and equity in classroom contexts. Using a triangulated qualitative design, the study combines group discussions, individual interviews and written reflections analysed through Grounded Theory Methodology. Findings show that pre-service biology teachers describe feeling powerless, insecure or inadequately prepared when confronted with inequity or diversity related content. Many report avoiding controversial issues and self-censoring for fear of responding incorrectly. There is a tendency to excuse discriminatory behaviour by individuals and not recognise structural patterns of discrimination. To respond to these challenges, the project develops a university seminar on diversity-sensitive biology teaching using a Design-Based-Research approach. Through iterative co-creation, structured reflection, and discourse-oriented activities, the seminar aims to enhance critical (self-)reflexivity and strengthen pre-service teachers' confidence and capacity to enact equitable and socially responsive biology education.

Relevance of task characteristics for preservice biology teachers' modelling processes

Felicitas Haupts, Jörg Großschedl, Nina Minkley, Till Schmäing and Moritz Krell

| Oral |

Keywords: *Modelling, Modelling Process, Preservice Teachers, Task Characteristics*
Submission #: 215

Models are an important tool extending to biology education, where models facilitate an understanding of complex phenomena and engage students in authentic scientific practices. Preservice biology teachers thus need modelling competences which comprise the knowledge and skills to develop and use models. Current research suggest that characteristics of a situation influence the modelling. This study investigates how specific task characteristics influence the modelling processes of preservice biology teachers. It asks how the recognisability of deep structures, the specific biological context, and the epistemological goal impact the perception of the modelling tasks. The study currently involves data of 20 German preservice teachers who each completed two digital modelling tasks with a systematic variation of task characteristics. The findings show, for example, that a significant proportion of participants did not perceive the epistemological goal of the task correctly. These findings will contribute to a better understanding of modelling processes and inform the design of modelling tasks that foster a deeper understanding.

Pre-service primary school teachers perceptions and preparedness to plan biology as inquiry

Karin Hecke and Isabel Jiménez Bargalló

| Oral |

Keywords: *Inquiry-Based Science Education, Teacher Training, Pre-Service Teachers, Perceived Competence, Teaching Efficacy, Biology Lesson Planning, Qualitative Content Analysis, Initial Teacher Education*

Submission #: 57

Teachers play an essential role in pupils' learning biology via inquiry based science education approaches. Therefore, it is essential that they necessary background and skills to feel confident and enact it in the classroom. In this sense, initial training education can play an essential role to support such kind of innovation. However, it is important to evaluate the impact of this inital training to ensure it is really achieving the desired impact. In order to do so, this research aims to understand the potential correlation between 85 preservice primary teachers' perceived competence and real abilities to plan biology lessons though an inquiry based science education approach. Perceived competence was analysed using the validated Inquiry-Based Science Teaching Efficacy Scale (Aydeniz et al., 2021). A conent analysis of lesson plans was also performed in order to analyse preservice teachers' planning abilities. Results show a clear mismatch between pre-service teachers perception of competence and actual abilities to do so. Implications to adjust initial training are discussed.

The effect of mechanistic and causal explanations on students' risk perception in a foodborne one health context

Benedikt Heuckmann and Marina Orth

| Symposia | 3: Morgenstern: Mechanistic reasoning in biology: Exploring processes, challenges, and educational Value

Keywords*: Mechanistic Explanations, Risk Perception, Risk Literacy, One Health*

Submission #: 86

Mechanistic explanations play a central role in biology education, as they help learners understand how underlying biological entities and activities give rise to observable phenomena. Prior research suggests that such explanations may also foster adequate risk perception, which is essential for developing risk literacy. This study examines how mechanistic versus causal explanations influence students' risk perception in a foodborne One Health context, using Shiga toxin-producing Escherichia coli (STEC) in flour as a societally relevant and curriculum-appropriate example. Using a 2 × 2 factorial design, we investigated (1) the complexity of students' explanations and (2) how instructional approach and explanation-oriented tasks affect cognitive and affective risk perception as well as perceived controllability. A 90-minute inquiry-based intervention was implemented with n = 66 students from grade 11. Students' explanations were analyzed using bottom-up scoring rubrics and open coding procedures. Likert-type risk perception measures showed acceptable reliability (α = .77–.90). Findings revealed substantial variation in explanatory complexity, with relatively few students generating mechanistic explanations. Mechanistically oriented instruction significantly promoted more complex explanations compared to causal instruction. Moreover, causal tasks were associated with increased and sometimes non-adequate risk perception, whereas mechanistic explanations supported more adequate perceptions of both risk and controllability. Students who provided mechanistic explanations perceived STEC-related risks as more controllable than those offering causal or no explanations. These results highlight mechanistic explanation as a domain-specific pathway through which biology education can contribute to students' risk literacy, emphasizing the need to explicitly foster mechanistic reasoning in classroom practice.

Mandate or motivation? an exploratory study of students' arguments and conceptual development on hepatitis b vaccination

Dagmar Hilfert-Rüppell, Katrin Vorhölter, Andreas Plink and

Manuela Harries

| Oral |

Keywords: *Interdisciplinary Learning, Students' Conception, Evaluative Competence, Epidemiological Modeling, Health Education, Data Literacy, Qualitative Content Analysis*

Submission #: 186

Relatively little is known about how secondary-school students' reason about a potential hepatitis B vaccination mandate, or whether their arguments form discrete patterns that can be modeled to capture different quality of argumentation as key to science education and evaluative competence. The present study provides a conceptual model for understanding variation in adolescent argumentation on public-health vaccination mandates and offers a basis for designing future interventions aimed at fostering evidence-based, reflective decision-making on vaccination mandate in science education. Free-response argumentations of 36 tenth- and eleventh-grade German students' were analyzed both before and after an interdisciplinary laboratory and modeling intervention. In a pre-/post written survey design, participants first reported their stance on mandatory hepatitis B immunization, then engaged in immunology experiments, epidemiological model-building, and structured discussions. All open-ended responses were subjected to qualitative content analysis. Six major argument categories emerged: (A) own knowledge gaps, (B) public health, (C) long-term consequences and side effects, (D) autonomy, (E) ethics and social responsibility, as well as (F) (mis)trust. Each category was further divided into subcategories for conceptual clarity and analytic depth. At pretest, almost three quarters of students offered no clear position, and some of those who did, admitted to gaps in their own knowledge. By the posttest, this category (A) was not found any more. Instead, students elaborated public-health arguments, articulated detailed risk - benefit analyses and reflections on autonomy. Ethical solidarity arguments also increased, while early conspiracy-theory claims vanished entirely. These findings demonstrate that an interdisciplinary module combining authentic data analysis, mathematical modelling, laboratory practice, and dialogic argumentation can not only expand content knowledge. It also appears to have strengthened students' informational basis strengthening evaluative competence. In the presentation, the six-category framework and further data will be presented, as the project is still ongoing.

Embedding one health socio-scientific issues in science classrooms: co-design and discourse practices between subject matter experts and pre-service teachers

Ulrich Hobusch, Petra Bezeljak Cerv, Uwe K. Simon, Benedikt Heuckmann, Gregor Torkar, Albert Zeyer, Sebastian Stuppan, Sascha Krebser, Franziska Messenboeck, Kerstin Kremer and Martin Scheuch

| Oral |

Keywords: *Science Education (Se), Teacher Education (Te), One Health (Oh), Education For Sustainable Development (Esd), Pedagogical Content Knowledge (Pck), Socio-Scientific Issue (Ssi), One Health Teaching Clinic (Ohtc), Two-Eyed Seeing (Tes), Synoptic Transfer Fr*
Submission #: 246

Addressing global sustainability and health challenges requires science education that treats One Health as a socio-scientific issue (SSI) and integrates scientific, cultural, ethical, and societal dimensions. This study was situated in the One Health Teaching Clinic, a 13-week co-design setting in which pre-service science teachers (PS-STs) collaborated with subject-matter experts (SMEs)—including physicians, veterinarians, and environmental scientists—to design and implement One Health lessons. Conceptually, we drew on One Health as SSI, the Refined Consensus Model of Pedagogical Content Knowledge (PCK), and the Synoptic Transfer Framework framed by Two-Eyed Seeing to examine how topic-specific PCK becomes visible and develops through interaction. Our dataset consisted of sentence-level transcripts from 69 co-design meetings (three meetings per SME–PS-ST pair; 23 pairings), comprising 22.311 sentences. First, we described participation patterns by comparing the proportion of SME versus PS-ST talk across meetings. Second, we applied simple lexical proxies—sentences containing science-related or classroom-related keywords—as macro-level indicators of shifts from content-focused to classroom-focused discourse. Third, we conducted focused discourse analysis of selected episodes to examine epistemic positioning, argumentative structures, uncertainty negotiation, and turn-taking as windows into knowledge co-construction. Findings showed a systematic shift from SME-dominated to PS-ST-dominated talk across the three meetings, accompanied by a decrease in science-related and an increase in classroom-related lexicon. Meeting 1 was characterized by scientific-integrity work and content-focused expert input, whereas Meetings 2 and 3 increasingly foregrounded PS-STs' lesson planning and reflection on implementation. We discuss how this co-design approach offers a promising

model for making topic-specific PCK visible and for developing actionable design heuristics to support teaching complex, uncertain, and value-laden One Health issues at the interface of science, health, and society.

Beliefs about sustainable and healthy nutrition among young students

Julia Holzer and Doris Elster

| Oral |

Keywords: *Theory Of Planned Behavior, Beliefs, Nutrition, Health And Environmental Education*

Submission #: 109

The sum of individual nutritional decisions not only influences personal health but also the environment. It is not always easy for individuals to make healthy and sustainable nutritional decisions. This study focuses on the individual level with the aim of understanding how young people rationalize their decisions to eat healthily and sustainably. The theory of planned behavior (TPB) is applied to answer this question. The attitudes (ATT), the subjective norm (SN), the perceived behavioral control (PBC), intention and the level of beliefs are analyzed. In addition to the TPB constructs, knowledge regarding sustainable and healthy nutrition is also considered. A total of 171 students (age ø: 17.3; n= 96 ♀/ n =75 ♂) from Bremen completed a questionnaire. The results clearly showed that ATT, PBC and knowledge correlate significantly and positively with the intention to eat sustainably and healthily. The study revealed a number of beliefs regarding why young people would or would not eat sustainably and healthily: the question of price, taste and the effort involved in buying the products and preparing the food played a major role. If the focus is placed primarily on ATT, PBC, beliefs and knowledge regard sustainable nutrition, then students can be sensibilized for a sustainable and healthy diet.

Structural and content aspects of argumentative writing by fifth-grade students' on a socio-scientific issue concerning human health

Ofra Ifrah, Orit Ben Zvi Assaraf and Tom Bielik

| Oral |

Keywords: *Socio-Scientific Issues (Ssis), Argumentation, Qualitative Data, Quantitative Data*

Submission #: 158

In an era defined by rapid change and global challenges, the ability to construct evidence-based arguments is a fundamental competency, particularly in biology education. This study examined the structural and content-related aspects of arguments written by 68 fifth-grade students in response to a Socioscientific Issue (SSI) concerning environmental pollution and human health, before any explicit instruction in argumentation. Structural analysis, based on Toulmin's model, evaluated the presence of core components: claim, data, and warrant. Content analysis examined the use of qualitative versus quantitative data, reliance on information sources, and the coherence of arguments. Structurally, most students constructed basic arguments (claim supported by data and/or warrant), though few included a counterargument. However, the content analysis revealed a significant gap between students' ability to follow the formal structure and their effective use of evidence. Most students relied on qualitative data (descriptive terms like "enormous"), despite the availability of quantitative information in the SSI text and accompanying chart. Statistical analysis showed that the use of qualitative data was significantly associated with stronger causal reasoning and greater coherence. These findings underscore the importance of explicit instruction that addresses both the structural features of scientific argumentation and supports elementary students in interpreting and utilizing scientific data from diverse sources. They further emphasize the importance of integrating SSIs into biology education to promote scientific literacy and critical thinking skills.

Seamind: improving knowledge, pro-environmental intentions, and connectedness to the sea through field-lab-classroom integration

Maria Ilia, Periklis Kleitou, Nikolaos Doumpas, Christina Michail, Christina Diamantoupoulou, Demetris Kletou and Konstantinos Korfiatis

| Poster |

Keywords: *Ocean Literacy, Marine Education, Nature Connectedness*
Submission #: 233

Ocean literacy is underrepresented in primary curricula, even though early experiences can shape lasting attitudes and behaviours. We evaluated SEAMIND, a five-day scientist–teacher programme that integrates shoreline fieldwork, institute-based lab sessions, and classroom learning. Using a repeated-measures pre-post design with students aged 8-12, we assessed module-specific knowledge and pro-environmental intentions, recorded confidence in answers, measured connectedness to the sea, tracked five feeling states before and after each day, and administered a 10-item global self-esteem scale at the start and end of each programme day. Analyses followed an a priori plan: item-level McNemar tests with Benjamini–Hochberg correction were used for knowledge and behavioural items, binary emotional engagement states were tested with paired McNemar tests, and a mixed-effects logistic model with fixed effects for Time (Post vs Pre), Domain (Knowledge vs Behaviour), and their interaction, plus age and gender as covariates, was fitted with random intercepts for participant and item. Model checks found no overdispersion. Knowledge increased robustly: the mixed model estimated approximately fourfold higher odds of a correct response after the programme. Behavioural intentions rose but were less consistent, reflecting the short duration. Emotional engagement shifted toward more positive states across all five days. Connectedness to the sea and global self-esteem moved in positive directions overall, with one competence-focused self-esteem item increasing significantly and negatively keyed items trending downward. Despite the small sample and brief exposure, the pattern is clear: short, place-based encounters at the sea, reinforced through linked lab and classroom activities, can deliver immediate learning gains and foster a positive climate for learning. SEAMIND's modular, low-cost design and ready-to-use materials support scalable implementation, offering a practical route to embed ocean literacy in ordinary schools.

Student silence in digitally mediated ssi discussions

Maria Jafari, Carolin Strehmel, Vanessa Meyer,

Nunzia-Mintaah Karunainathan and Anke Meisert

| Poster |

Keywords: *Digital Learning Platform, Socio-Scientific Issues, Group Discussions, Abortion*

Submission #: 19

Socio-scientific issues (SSIs), such as abortion, require scientific understanding and public deliberation. Because of this, group discussion is a core practice in science education as it fosters collective reasoning and decision making. Yet many students struggle in un-scaffolded discussions because they must simultaneously search and appraise information, formulate claims and respond to counterarguments. Digital learning environments promise broader access to resources and lower barriers to participation, but their effects on collaborative talk remain unclear. Therefore, this study adapted an established analogue framework for structuring SSI discussions to a digital platform and examined how students navigated resources and interacted. Ninth-grade students (N = 80) from seven classes at four secondary schools in Germany worked in 25 groups on whether the legal time limit for abortion should be extended. The platform provided topic pages and shared workspaces. Screen and audio recordings captured navigation and interaction. Data were analysed using qualitative content analysis. Perceived usability (0–100) and collaboration (5-point scale) were assessed by questionnaire. Findings show that students spent most time on overview pages (78%). Overall, 83% of students formulated at least one argument and 58% replied to a peer. Groups met for 25 minutes and 30% of the time involved discussion. Usability averaged 74.5; collaboration was rated 3.78 (SD = 0.80). Findings indicate that the digital format shifted activity from dialogue toward individual and silent work. The mismatch between usability and interaction suggests that user-friendliness alone does not ensure pedagogical quality. The implications for teaching and educational research are discussed.

Reasons of biology major and future biology teacher to study biology

Vanda Janštová and Eva Krkavcová

| Poster |

Keywords: *Interest In Nature, Teacher Influence, Biology Olympiad*

Submission #: 31

Declining STEM performance and graduate numbers in the EU motivated this study into factors shaping tertiary biology enrollment; it aims to identify antecedents of interest in nature and determinants of the decision to pursue either a biology major or biology teacher training. An anonymous 17-item survey (piloted) was administered to 305 first- and second-year students at Charles University (Faculty of Science, n = 157; Faculty of Education, n = 148) using convenience sampling. Open responses were categorized and coded, and analyses comprised descriptive statistics and χ^2 tests of association and goodness-of-fit with Bonferroni correction. Most respondents reported that interest in biology developed during secondary education, with family and secondary-school biology teachers exerting significant influence. Compared to future teachers, biology majors were more strongly motivated by individual interest and peer influence, envisioned more interesting future employment, valued opportunities to study abroad and encounters with university teachers who are experts in their fields, and were more often motivated by taking part in Biology Olympiad and showed interest in nonpopular botany. Most students enrolled in their preferred programs; medical studies were the primary alternative for science-track students. Enduring interest in biology—shaped by early exposure and influential secondary-school teachers—constitutes the principal motivation for university study. Tailored interventions enhancing secondary biology instruction, extracurricular engagement, and visibility of career and international opportunities may strengthen recruitment and retention across distinct

Identifying preconceptions in developmental aspects of evolution

Isabel Jiménez-Bargalló and Jordi Martí-Feixas

| Oral |

Keywords: *Preconceptions, Developmental Evolution, Content Analysis, Compulsory Education, Pre-Service Teachers*

Submission #: 92

Despite the central role of evolution in life sciences, its marginalization and bias in compulsory education is well known. Against this backdrop, some scholars advocate for a new and contemporary perspective on teaching evolution, which should start at early ages and should take into account the interaction between evolutionary and developmental processes. Furthermore, in agreement with the ideas of conceptual change, it is important to understand students' ideas to use them as starting points for planning, eventhough litte is kwown about undergradute ideas regarding evo-devo topics. In this context, this study examines students' pre-conceptions about developmental biology from an evolutionary perspective. 91 primary and secondary students (age range 10-16) and 25 pre-service teachers (age range 20-23) answered two open-ended questions regarding (1) similarities between embryos of different species; and (2) development of a limb within a human embryo. Participants' responses were analyzed via content analysis. Categories emerged inductively from data. Results show multiple black boxes within participants' preconceptions and no pattern or trend that indicates an evolution of ideas throughout schooling. Possible stepping stones as starting points for planning can also be identified.

Enhancing continuity in science education: aligning early childhood and primary teacher education programmes in estonia

Kaire Jõgi and Aigi Kikkas

| Poster |

Keywords: *Pre-Service Teachers, Teacher Education, Science Teaching, Pedagogical Continuity*

Submission #: 235

Developing learners' scientific literacy requires a coherent and progressive learning pathway that enables children to move from experiential exploration toward increasingly complex scientific reasoning. Although both the Early Childhood Education (ECE) and Basic School national curricula in Estonia emphasise inquiry-based learning, environmental awareness, and active engagement with phenomena, continuity between educational levels depends heavily on how teachers are prepared to interpret and implement these principles. Research shows that pedagogical continuity may break down when teachers have limited insight into learners' prior experiences or when teacher education programmes treat educational levels in isolation. This study addresses the need for a more integrated approach within teacher education by examining how science education is conceptualised in the Early Childhood Education Teacher (ECET) and Primary School Teacher (PST) programmes, and by identifying elements that support continuity between early childhood and primary school science education. Using a qualitative design, the study analyses three sets of data: national curricula, teacher education programme documents, and perspectives gathered through focus group interviews with ECET and PST students. Researcher diaries, maintained by two science education lecturers, provide an additional lens on student challenges, including scientific misconceptions and difficulties interpreting curriculum aims. Document analysis combined deductive and inductive coding to identify programme-specific gaps. Thematic analysis of focus group interviews highlights perceived strengths and challenges in ensuring continuity between educational levels. Findings demonstrate that although national curricula articulate a coherent developmental trajectory—from noticing and exploring environmental phenomena in early childhood to understanding causality and applying scientific explanations in primary school—this progression is not fully mirrored in teacher education. ECET courses prioritise experiential learning and environmental engagement, while PST courses centre on conceptual understanding and scientific practices. However, teacher candidates receive limited guidance on how these approaches connect or how children's learning evolves across levels. This fragmentation risks creating inconsistencies in teaching practices and disruptions in pupils' science learning trajectories. The study concludes that a continuity-oriented model is needed to integrate science-related components across the ECET and PST programmes. Such a model should strengthen cross-level coordination, clarify developmental expectations, and support teacher

candidates in understanding how early experiences form the foundation for later scientific reasoning. Establishing this coherence is essential for supporting the progressive development of scientific literacy throughout the educational pathway.

A case study on how spatial affordances shape first-grade students' participation in biology inquiry phases within innovative learning environments

Leonie Johann, Magdalena Kersting and Sara Wilmes

| Poster |

Keywords: *Student Participation, Innovative Learning Environments, Spatial Resources, Inquiry Based Science Education, Early Elementary Education*

Submission #: 250

To address 21st-century challenges, the OECD promotes Innovative Learning Environments (ILE), which offer spatial flexibility and resource access beyond traditional classrooms. In Norway, ILE are often conceptualized as out-of-school spaces for inquiry-based science education (IBSE), such as Newton Rooms. IBSE emphasises student-centered learning through collaborative work and reflective discussion, yet concerns persist about whether students participate as intended. While participation is typically studied through verbal interactions, little is known about how spatial resources and teacher coordination shape engagement in ILE. This study explores students' participation patterns during an inquiry unit on insect ecology, drawing on the ecological view of embodiment, Gibson's affordances, and social semiotic theory. Data comprise approximately 12 hours of video from Newton Room sessions involving two first-grade classes (ages 6–7) and an experienced teacher. Using a lesson-study approach, episodes were coded for accessibility of materials, teacher facilitation, and students' multimodal involvement, followed by fine-grained multimodal interaction analysis. Findings reveal three participation patterns: minimal multimodal and spatial engagement, limited multimodal participation with some spatial involvement, and high multimodal and spatial participation. Constraints included limited teacher spatial coordination and unclear material affordances, suggesting that ILE do not inherently foster collaborative, embodied learning. Effective orchestration of spatial resources is essential to support scientific meaning-making. This study contributes methodological and conceptual insights into participation in innovative learning spaces and underscores the need to integrate spatial dimensions into science education research and practice.

Educational reconstruction of climate-regulating functions of plants

Maren Junker and Sarah Dannemann

| Poster |

Keywords: *System Thinking, Model Of Educational Reconstruction, Esd, One Health, Conceptual Reconstruction, Students' Conceptions, Theory Of Experientialism, Plant Awareness, Climate Change, Urban Ecology*

Submission #: 273

Heat as an effect of climate change is considered one of the central challenges of our common future. Biologists consider plants crucial for cooling, largely due to their key function in water evaporation. The Model of Eduational Reconstruction makes it possible to critically examine subject-specific concepts of scientists in terms of teaching objectives and, by relating them with students' conceptions, to develop technical clarified concepts that enable meaningful learning. The study addresses three central research questions: (1) How do scientists conceptualize climate-regulating plant functions? (2) How do secondary school students conceptualize these functions? (3) Which learning opportunities enable a technically appropriate understanding? Qualitative methods are employed, combining Qualitative Content Analysis and Systematic Metaphor Analysis on linguistic material (textbooks and interviews). Preliminary findings from the research task of the critical subject-specific clarification reveal inconsistencies: cooling is described both as active temperature lowering and as maintaining a constant temperature. The underlying energetic mechanism is framed as "energy disposal" through evaporation, which prevents warming caused by thermal convection. Explicitly connecting system levels could be promising in order to enable causal explanations with links between energy, phase change and temperature. This contribution focuses on scientists' conceptions.

Designing for expansive learning: how flexible citizen science curricula can empower students' agency

Yael Kali, Ornit Sagy, Yael Bar Nes and Amram Eshel

| Symposia | 1: Tsybulsky: Transforming Biology and Environmental Education through Citizen Science

Keywords: *Expansive Learning, Citizen Science, Student Agency, Flexible Curriculum, Environmental Education*

Submission #: 72

School participation in citizen science (SPICES) is a growing practice, especially in biology and environmental education. However, the literature shows that the school setting often serves as a diminishing factor in learners' tendency to frame their learning in the citizen science project expansively, thus decreasing the potential of SPICES to foster their agency and environmental citizenship. The current study sought to explore how the flexible design of SPICES curriculum materials may offer opportunities to promote the development of expansive framings among students at various age levels. We did so by analyzing how students framed their learning within different implementations of The Bermuda Buttercup Mystery initiative. This SPICES program, addressing invasive plant species as a real-world ecological issue, was designed flexibly to support adaptations required for its incorporation into diverse school contexts. In-depth group interviews with students were conducted in three different age-level classes using a multiple case-study approach. Findings indicate that across cases, three main categories of expansive framing emerged: an "ambassadorship" framing, a "helping the scientist" framing, and an "advancing knowledge" framing. We argue that the expansive framings identified are related to different emphases embedded in each implementation, which the flexible design of The Bermuda Buttercup Mystery enabled. These findings illustrate how citizen science can transform biology and environmental education by connecting scientific inquiry, ecological awareness, and student agency.

Emotional awareness in teachers' action competence for sustainability and climate change education

Mary Kaya, Nina Christenson, Jelle Boeve-de Pauw and Niklas Gericke

| Oral |

Keywords: *Climate Change Education, Professional Action Competence, Emotional Awareness*

Submission #: 159

Teachers, as key change agents in implementing action-oriented sustainability and climate change education (SCCE), play a crucial role in helping students navigate the complexity and uncertainty of sustainability challenges. Teachers need professional action competence (PAC) in managing emotions in classroom settings to help students navigate the emotional dimensions of sustainability challenges while fostering resilience and constructive engagement, e.g., cultivating climate actions. This raises the question of how teachers experience their competence to address students' emotional reactions within SCCE. Therefore, this study aims to explore how teachers perceive their PAC to enact emotional awareness within action-oriented SCCE. Guided by a PAC framework encompassing Professional Knowledge (PK), Self-Efficacy (SE), and Willingness to Teach (WTA) SCCE, an exploratory survey was conducted with 202 (compulsory and upper-secondary) in-service teachers in Sweden. The results suggest that teachers feel somewhat more competent in fostering positive emotions through lesson design and discussion but feel less equipped to handle emotionally challenging situations within action-oriented SCCE, particularly those involving negative emotions such as worry, frustration, or anxiety. The findings highlight the importance of supporting teachers' PAC through targeted professional development programs with focus on emotional awareness to strengthen teachers' capacity to recognize students' emotions as catalysts for action. Integrating emotional awareness can build teachers' capacity to recognize, evaluate and use students' emotions and coping strategies as catalysts for taking actions, thereby promoting the effective implementation of SCCE in classrooms and school environments.

Interest-based learning units for the immune system: integrating students' autonomy with curriculum requirements

Noa Kedar, Moriah Ariely and Anat Yarden

| Oral |

Keywords: *Interest, Student Autonomy, Learning-Units Design, Immune System, Online Learning Environment*

Submission #: 205

This study examines an online high-school course on the immune system that integrated students' interests into the design of four thematic learning-units. The units were developed based on 423 student-generated questions and combined with all the required content from the national biology curriculum, creating interest-based learning units that included curricular requirements. Each unit included the same core content knowledge in a different context. A total of 126 students completed the units, out of which 98 selected the learning units that aligned with their personal interests, and 28 were randomly assigned to a learning-unit. We assessed the potential influence of the units' context on students' achievement by assigning each student a score and then calculating learning-unit–level statistics. We also analyzed students' responses to an interest questionnaire at the end of the course. Findings showed that students' achievements did not differ across the learning units, indicating that core curriculum learning was consistent regardless of the interest-based context. However, students who selected their own units reported higher levels of situational interest and felt that the unit addressed their personal questions more strongly than those who did not choose a learning unit. These results highlight the value of incorporating students' interests into curriculum design. Developing interest-based pathways that align with required content may enhance students' engagement and sense of relevance without compromising academic outcomes. This approach offers a model for creating science learning experiences that support student autonomy while maintaining alignment with disciplinary standards.

Big ideas in elementary school: a new curriculum for learning about evolution by natural selection in third grade (symposium: evolution education in early years)

Deborah Kelemen, Sarah Brown, Alden Burnham, Eli Elster,

Léa Combette, Gillian Puttick, Sally Crissman and Sara Lacy

| Symposia | 5: Pessoa: EVOLUTION EDUCATION IN THE EARLY YEARS

Keywords: *Primary School, Evolution By Natural Selection, Curriculum, Conceptual Change, Cognitive Science*

Submission #: 66

Natural selection is a fundamental mechanism of evolution yet remains widely misunderstood. Rather than understanding that specialized traits (adaptation) or new species (speciation) can arise because of differential effects of environmental contexts on variable populations, students instead often teleologically assume species change occurs because individuals transform their traits, or essential nature, due to need. Misunderstandings are traceable to intuitive tendencies –e.g. teleological and essentialist biases–that develop early yet are typically educationally uncontested until adolescence when they are harder to inhibit, rendering construction and application of scientific accounts difficult. This talk overviews research that has sought to address this challenge by designing a comprehensive curriculum on evolution for elementary school. One question was whether a coherent sequence of investigations and storybook-based activities integrated around the process of natural selection would promote mechanistic understanding of not only smaller-scale evolutionary change (e.g. within-species adaptation) but also larger-scale evolutionary concepts (speciation, common ancestry). A further question was whether a curriculum that encompasses larger-scale evolutionary concepts is so cognitively overtaxing that it ultimately undermines 8-year-olds' learning of natural selection. US third graders (n=134) who completed the comprehensive 12-lesson curriculum showed significant pre- to-post-test learning effects. Comparisons to students (n=268) who completed an easier 7-lesson version (on within-species adaptation only) found no group differences in natural selection understanding. Comprehensive classroom instruction on evolution by natural selection in early elementary school is therefore viable: Additional exposure to larger-scale evolutionary concepts does not harm younger students' learning. Implications for conceptual change research and policy will be discussed.

Framing sexuality education in biology: a qualitative content analysis of external providers in three austrian regions

Gudrun Kern and Uwe Simon

| Oral |

Keywords: *School-Based Sexuality Education, Biology Education And The Didactics Of Sexual Education, External Sexuality Education Providers In Austrian Schools, Gender And Sexual Diversity In Biology Education*

Submission #: 165

Sexuality education in Austria is formally anchored in biology and related school subjects, but in everyday school life it is often shared between teachers and external organizations. This contribution presents a qualitative content analysis of publicly available resources from external sexuality education providers that work with schools in three Austrian federal states (Carinthia, Burgenland and Styria). The study asks which thematic areas these actors communicate in their public offers and how these relate to international frameworks of comprehensive sexuality education as well as current debates in biology education. Seventeen organizations were identified through official lists and cooperation frameworks with schools. In total, 67 webpages, flyers and workshop descriptions were analysed using qualitative content analysis with a deductive-inductive coding framework. Drawing on international comprehensive sexuality education frameworks, eleven key themes were developed deductively. Through inductive analysis of 67 webpages, flyers and other online-resources, these themes were elaborated into a coding framework with a total of 109 categories, which was refined in several rounds of piloting and intercoder checks. Coding and analysis were carried out with MAXQDA. The findings show a strong emphasis on bodily and reproductive knowledge, emotional development, the prevention of sexually transmitted infections and the protection from sexual violence. These areas correspond closely to core components of international frameworks. At the same time, topics such as sexual pleasure, autonomy, consent as a positive relational practice, queer* and trans* lives, migration and intersectional experiences appear only marginally or not at all. Fears that external providers would mainly focus on LGBTQIA+ issues are not supported by the data. The contribution discusses how these framings of sexuality education interact with school-based biology teaching and the established role of external providers, and reflects on implications for school-cooperation with external experts.

Designing a course to support primary school teacher students' understanding of the nature of science

Aigi Kikkas, Regina Soobard and Miia Rannikmäe

| Oral |

Keywords: *Nature Of Science, Primary School Teacher Students', Designing A Course*
Submission #: 230

Understanding the Nature of Science (NOS) is internationally recognised as a key component of scientific literacy (Lederman, 2007). Research shows that pre-service teachers often enter university with naïve, narrow, or stereotypical conceptions of science shaped by schooling, media, and cultural representations. This study presents an explicitly reflective NOS course designed to support the development of primary teacher students' understanding of the nature of science, and examines changes in their views of science, scientists, and the aims of science education throughout the course. A mixed-methods design was used, combining data from the VOSE questionnaire with a Draw-a-Scientist task and a concept-mapping activity focusing on the aims of science education. Participants were 39 second-year primary teacher education students. Quantitative findings showed significant improvements in several NOS dimensions, including the role of imagination and creativity in science, the tentative and evolving nature of scientific knowledge, the distinction between theories and laws, and the influence of subjectivity and socio-cultural factors. Qualitative results indicated that participants initially held stereotypical images of scientists and limited understandings of scientific literacy. Although the course enhanced students' NOS understanding, the development of a broader perspective on the aims of science education appears to require longer-term, sustained support.

Measuring students' perceived competence during experimentation

Tim Kirchhoff, Matthias Wilde, Christoph Randler and Nadine Großmann

| Oral |

Keywords: *Experimentation, Perceived Competence, Questionaire Development*
Submission #: 127

Students' perceived competence during activities in school, such as experimentation in biology education, is of unique importance for their motivation and learning. As experimentation comprises searching hypothesis, testing hypotheses, and evaluate evidence, a differentiated investigation of perceived competence during these phases is required to gain a clearer understanding of motivational processes during experimentation. However, existing scales do not assess specific aspects of an action. Consequently, we developed a short scale to assess students' perceived competence during experiments using the Scientific Discovery as Dual Search model. After a previous pilot test, we aim to investigate the reliability, factorial validity, and construct validity of the scale. Our sample comprises 403 students (Mage=16.48 years, SDage=0.79 years, 56% female) who performed an experiment in biology classes. The analyses revealed that the scale has good psychometric properties: Three reliable factors for Searching Hypothesis, Testing Hypotheses, and Evaluate Evidence were confirmed. Additional correlation analyses support the construct validity. The scale can be used for a differentiated assessment of perceived competence during experimentation and allows a nuanced investigation of contextual factors for experimentation.

Citizen science in freshwater research for students

Svea Isabel Kleinert, Justin Timm, Nora Lösing, Carolyn Erben, Jan Koschorreck, Florian Leese, Antje Ullrich, Marie-Thérése Werner and Philipp Schmiemann

| Poster |

Keywords: *Citizen Science, Freshwater Ecosystems, Environmental Education, Design-Based Research*

Submission #: 232

From an ecological, economic, and social perspective, freshwaters are considered important ecosystems whose protection and renaturation can be emphasized as a task for society. This requires extensive monitoring of all relevant freshwaters. eDNA metabarcoding is a promising method of official water monitoring. The relevance of aquatic ecosystems is also reflected in school curricula. Citizen science projects offer one way of integrating water protection-related content into the classroom. These projects contribute to filling gaps in students' knowledge about these ecosystems and promoting interest and environmental awareness. Our citizen science project aims to integrate water protection topics into biology and science lessons and evaluate the potential of this approach for synergistic effects in official water monitoring. As part of the project, teaching and learning materials for primary and secondary schools are being developed, each containing four sequences. Currently, the learning materials for the first sequence have been designed and used in the first sampling period. In addition to educational videos introducing the project content, these include instructions for environmental DNA sampling and further water tests. To evaluate the learning materials in an iterative optimization process following a design-based research approach, part of the participating teachers will be interviewed. Using guided interviews, teachers are asked to assess the suitability of the materials for curricular requirements, their level of support and their effectiveness. The findings will be used to revise and optimize the teaching and learning materials. The interviews are currently being conducted. Initial results will be presented at ERIDOB.

Talking science over coffee – identifying design features that foster interest and understanding of science

Julian Kokott and Annette Scheersoi

| Oral |

Keywords: *Interest Development, Nature Of Science, Public Engagement, Dialogic Encounters*

Submission #: 266

As societal challenges and uncertainty grow, science communication (SC) must strengthen public engagement and informed decision-making. However, research has only recently begun to investigate how dialogue-based formats can promote interest in science and support understanding of the Nature of Science (NOS). This study addresses this gap by examining how specific design features of a low-threshold, dialogue-oriented SC format can stimulate interest in sustainability-related biology themes and enhance NOS-related understanding among citizens. Drawing on the Person-Object Theory of Interest and established NOS frameworks, we developed and tested a "Science Café – Coffee Chat with Researchers." Three events were conducted in an urban café, each focusing on a sustainability-related biology theme and involving rotating small-group conversations with researchers from different disciplines. Data included participant observation and 26 semi-structured interviews with citizens and researchers, analysed through qualitative content analysis. Findings show that the Science Cafés fostered interest and NOS-related understanding. Participants valued the informal setting, personal contact with researchers, and opportunities for genuine dialogue. These features lowered participation barriers, supported engagement, and encouraged reflection on scientific processes. However, some participants noted challenges related to unequal participation, highlighting the need for researchers to develop dialogic communication skills. Researchers themselves reported gains in communication competence, insights into public perspectives, and inspiration for their own work. The study provides evidence that low-threshold, dialogic SC formats can effectively strengthen public interest in science and deepen NOS understanding, offering concrete implications for designing inclusive and engaging SC initiatives.

Ai-enhanced e-learning in wartime: assessing the didactic feasibility of a gamified biochemistry course in ukrainian universities

Iryna Kompanets, Sabine Roemer, Olga Molozhava, Oleksandr Savchenko, Stephanie Heimgartner and Kornelia Freitag

| Poster |

Keywords: *Gamified E-Learning, Story-Telling, Ai-Generated Images, Biochemistry Digital Course, Digilabstar Project, Moodle, Actionbound*

Submission #: 55

The Russian invasion of Ukraine has forced universities to shift to remote and blended formats, intensifying the need for flexible and engaging learning tools in Biology education. Gamified digital courses—supported by AI, storytelling, and animation—offer new opportunities for student engagement and retention under stress. This case study was conducted under the DAAD-funded DigiLabStar III project hosted by Ruhr University Bochum, aiming to evaluate the didactic feasibility of an AI-enhanced Biochemistry course used across 11 Ukrainian universities. Key objectives included assessing the relevance of gamified learning, the role of AI tools in narrative and visual content creation, and educators' readiness to implement these innovations. 62 university lecturers completed a reflective questionnaire. Results showed that 53% completely agreed gamified content is appropriate for Biochemistry education; 61% found it suitable for bachelor-level students. Story-based Vyond animations improved engagement (48%) and understanding (47%). Interactive tasks increased motivation (53%), knowledge retention (55%), and critical thinking (44%). Only 2% strongly agreed that animations could be distracting. AI-generated narratives were viewed as helpful when combined with teacher input (50% mostly agree), while 70% considered AI visuals moderately appropriate. 74% of lecturers plan to develop gamified modules. 56% fully agreed gamified learning supports teaching during wartime. Conclusion: AI-supported gamified learning is a relevant and scalable strategy for Biology education in crisis contexts, fostering engagement, motivation, and retention—when guided by sound pedagogical oversight.

Reflection, pck, and professional vision: insights from pre-service biology teachers' practice

Jitka Kopecká

| Oral |

Keywords: *Professional Development, Pre-Service Teacher Education, Competence Framework, Teaching Practice Reflection*

Submission #: 68

The paper focuses on the development of professional preparedness and pedagogical content knowledge (PCK) among pre-service teachers of science and biology within the context of the newly defined Competence Framework for Graduates of Teacher Education Programmes (Ministry of Education, Youth and Sports of the Czech Republic, 2023). Based on a questionnaire survey conducted among student teachers from four Czech universities (n = 158), the study analyses their reflections on teaching practice, choices of instructional strategies, approaches to student engagement, and perceptions of their emerging professional identity. The findings indicate that the participants feel more confident in biological topics than in geological ones, tend to prefer traditional forms of instruction, yet simultaneously recognize the value of inquiry-based and hands-on learning activities. The paper concludes with a discussion on how these insights may contribute to the development of teachers' professional vision and to the cultivation of their PCK in alignment with the national competence framework.

Fostering plant awareness in early years: activities and assessment of their effectiveness

Marjanca Kos and Špela Klofutar

| Poster |

Keywords: *Plant Awareness, Early Years, Plants, Children, Early Science Education*
Submission #: 244

Plants are an integral part of children's lives and surroundings. Despite their fundamental importance for life on Earth, they are often overlooked, even by adults. As early childhood is a crucial period for shaping lifelong attitudes towards living beings, efforts to address this issue should begin already in preschool education. The aim of this study was to design a set of activities appropriate for preschool children and to assess its effectiveness in fostering plant awareness. The research focused on the domains of visual perception of plants and attitudes towards plants. The sample comprised 47 children aged four and five years. A quasi-experiment was conducted. Initial individual interviews sought to identify the children's initial level of plant visual perception and attitudes. Children in the experimental group subsequently participated in the intervention, which involved active and experiential learning about plants through six activities, which included playful interactions with plants in outdoor environments. The control group did not participate in any plant-related activities. Finally, the interviews were repeated for both groups. The results showed that the designed and implemented set of activities significantly and positively affected the experimental group children's visual perception of and attitudes towards plants. This effect was not observed in the control group. The study provides empirical evidence that this set of activities is an effective educational tool. We suggest that educators implement it into their regular practice to foster plant awareness from an early age.

Animals and anthropomorphism in children's literature: implications for learning about nature

Panagiota Kotsakiozi, Panayiotis Pafilis, Efstratios Valakos and Martha Georgiou

| Poster |

Keywords: *Animal Representations, Anthropomorphism In Stories, Children'S Literature, Biology Education, Students' Conceptions*

Submission #: 224

This study explores how animals are depicted in Greek children's literature of the 20th century, with a particular interest in the ways anthropomorphism shapes young readers' understandings of nature. Picture books often serve as an accessible introduction to biological ideas, yet the way animals are represented can influence how children imagine the natural world. Giving animals human voices, feelings, or habits may make stories more engaging, but it can also blur the line between fiction and reality. The analysis of a large selection of award-winning books shows clear patterns. Mammals and birds dominate the stories, while many other groups—especially invertebrates—rarely appear. Anthropomorphism is also widespread, particularly in books for younger children, and is most often associated with the main characters. These tendencies collectively offer children a partly filtered view of biodiversity and may encourage misconceptions about how real animals behave or relate to humans. Overall, the findings suggest that children's literature can be a valuable support for early science learning, provided it is used thoughtfully. When teachers help students distinguish imaginative story elements from biological facts, picture books can spark curiosity without reinforcing inaccurate ideas. Pairing literary narratives with authentic examples from nature may offer a more balanced foundation for learning about animals and the wider living world.

Enhancing sustainability consciousness in sixth grade: evidence from an integrated esd and sel program from greece

Myrto Koutra-Iliopoulou, Apostolia Galani, Aikaterini

Plakitsi and Evangelia Mavrikaki

| Oral |

Keywords: *Education For Sustainable Development, Social And Emotional Learning, Sustainability Consciousness, Primary Education, Experiential Education*

Submission #: 238

Education for Sustainable Development is recognised as a key dimension of quality education and an essential pathway for helping learners understand and respond to sustainability challenges. This study examines the impact of an integrated ESD and Social and Emotional Learning programme on sixth grade pupils' sustainability consciousness in Greek primary schools. The program was developed within a doctoral research project and aimed to promote engagement with the Sustainable Development Goals while strengthening communication, collaboration and emotional understanding through SEL principles. The study used quantitative pre post design. The Experimental Group participated in the ESD and SEL based programme, while the Control Group continued with regular instruction. Sustainability consciousness was measured using the short version of the Sustainability Consciousness Questionnaire, adapted for Greek primary pupils through translation, back translation, expert review and pilot testing. This submission focuses on sixth grade data. The findings show clear improvements in the Experimental Group across all three dimensions of Sustainability Consciousness, with increases in mean scores supported by high reliability and large effect sizes. In the Control Group, statistically significant differences were observed, with slightly higher pre test scores and a small effect size, indicating limited practical relevance. This contrast supports the conclusion that the gains in the Experimental Group are linked to the intervention. Overall, the study provides evidence that holistic and socially supportive ESD approaches can enhance sustainability learning and promote deeper engagement among primary school pupils.

Ai-powered generating mcqs for assessments in biology

Tetiana Krushynska and Jani Ursin

| Poster |

Keywords: *Multiple-Choice Questions, Generative Ai, Modelling, Evaluation In Biology*
Submission #: 5

Multiple-choice questions (MCQs) are widely used in biology assessments, though their prevalence varies across European countries. While national exams in Finland, Poland, and Ukraine include MCQs, other countries such as France, Italy, Spain, and Germany primarily use them in classroom settings. Developing high-quality MCQs that assess higher-order thinking remains a challenge, particularly in biology, where much of the content lacks formalization. Nevertheless, the structured nature of biological knowledge allows for concept mapping as a foundation for standardized assessment design. This study presents a collaborative human–AI model for generating original MCQs from educational texts using large language models (LLMs). The model structures the task into three AI-assisted steps: compiling a concept map, formulating a question with a correct answer, and generating plausible distractors. Prompt engineering combined rule-based and example-based techniques to guide AI outputs. The simulation was conducted by the author acting as a biology teacher. Four freely available AI tools were tested using textbook fragments and learning objectives. Of 96 generated MCQs, 30.2% were initially acceptable. Distributing prompts among AIs improved the acceptance rate to 55%, and further manual or AI-assisted editing raised it to 77.5%. Plagiarism checks confirmed 94% originality. The findings demonstrate that structured prompting and human oversight can yield high-quality, scientifically accurate MCQs without requiring AI model training or advanced technical skills. This approach offers a scalable solution for biology educators seeking efficient assessment development and supports the integration of AI into classroom and exam design.

A physical model of the nervous system systematically developed for increasing student motivation and understanding

Pål Kvello, Zhuo Li and Lars Lundheim

| Poster |

Keywords: *Neuroscience Education, Teaching Models, Systems Thinking, Self-Determination Theory, Nervous System, Motivation, Conceptual Understanding*
Submission #: 218

Human thoughts, feelings and behaviors are deeply intertwined with the sense of self, making it difficult to perceive these processes as mere functions of a physical organ. Neurological disorders such as Schizophrenia, Parkinson's disease, Autism, and Alzheimer's reveal that the Self is rooted in the nervous system, and structural changes in this system alter fundamental aspects of who we are. Understanding such disorders of thoughts, feelings and behaviors, or their healthy counterparts, requires knowledge of neural networks. However, this is rarely addressed in compulsory education. Neuron and brain function are present but the relationship between them is not. It is considered too complex. A common strategy for addressing complexity in education is the use of teaching models. Existing models include the brain, spinal cord, nerves, ganglia, and neurons, but most of them are restricted to structure and emphasize parts rather than the whole system. Consequently, we need a model with a holistic perspective. A model can be defined as a representation designed to display specific features or relationships of the original system with the purpose of simplifying, explaining, or predicting its behavior. Applying this definition in the present study requires identifying and simplifying key features of the nervous system while ensuring explanatory power. Furthermore, since model design influences engagement, motivational principles must guide development. Therefore, this study had three objectives: (1) identify and simplify key features of the nervous system, (2) determine design features that support student motivation, and (3) apply these features to develop a model. To achieve this, we conducted two literature reviews. The first, guided by systems thinking (Arnold & Wade, 2015), analyzed sources like Kandel et al. (2013) and Kvello & Gericke (2021) to identify key nervous system features. The second, based on Self-Determination Theory (Deci & Ryan, 2008), examined motivational elements and translated them into physical design features. Findings indicate that key features include neurons, synapses, neural circuit architectures, membrane potentials and their relationships. These were simplified using an argumentation-based approach. Motivational design features were categorized according to their potential to facilitate student autonomy, competence, and relatedness. Based on these results, a neuron-based model of the nervous system was developed to provide a holistic and pedagogically effective representation. This work contributes to neuroscience education by proposing a rigorously designed model that integrates structural and functional

perspectives while fostering student motivation. Future research should evaluate its impact on conceptual understanding and motivation in diverse educational contexts.

Assessing science teacher preparedness for sustainability and energy education: development of a readiness index

Anne Laius and Rolf Saarna

| Poster |

Keywords: *Readiness Index, Science Teacher Preparedness, Sustainability Education, Education For Sustainable Development, Pedagogical Professionalization*

Submission #: 28

This study develops and applies a Readiness Index to assess in-service science teachers' preparedness for integrating sustainability and energy topics into their teaching. It addresses the limited evidence on how specific pedagogical practices, curriculum integration, and professional partnerships influence teacher capacity within Education for Sustainable Development (ESD). A cross-sectional survey of 25 science teachers was conducted. The Readiness Index (0–8) was constructed from eight binary indicators encompassing pedagogical strategies, subject integration, and external collaborations. Descriptive statistics were used to examine distribution patterns, Mann–Whitney U tests to explore differences by subject area and teaching experience, and Spearman's ρ correlations to identify the strongest factors associated with readiness. Results indicate that teacher preparedness is generally low, with most participants scoring ≤1 and none exceeding 4 out of 8. Geography teachers reported significantly lower readiness, while teaching experience showed no consistent effect. The strongest positive associations with readiness were company/NGO partnerships, practical teaching methods, and university partnerships. Moderate associations were observed for emphasis on environmental issues, use of updated scientific resources, and integration of sustainability topics across subjects.

Main: action-oriented sustainability teaching: stakeholder perspectives on opportunities and challenges

Peter Lampert, Carole Chappuis, Teresa Berglund and Niklas Gericke

| Symposia | 7: Lampert: Action-Oriented Teaching for Biodiversity: Exploring Dynamics of Change

Keywords: *Sustainability, Biodiversity, Action-Oriented Education, Stakeholder Involvement, Action Competence*

Submission #: 175

Addressing sustainability issues is a challenge for educators (Boeve-de Pauw et al., 2022). Powerful learning environments for teaching about sustainability issues require combining holistic, pluralistic, and action-oriented elements (Sinakou et al., 2019). Studies show that implementing the action-oriented element, in particular, is complex (Boeve-de Pauw et al., 2022; Duifhuis et al., 2025). Therefore, this symposium discusses opportunities, challenges, and other key considerations related to action-oriented approaches, using biodiversity loss as a relevant case. The symposium presents three studies investigating the perspectives of different stakeholder groups: 1) in-service teachers, 2) pre-service teachers, 3) external stakeholders. Studies included in the symposium: Study 1: “Action-oriented teaching for Biodiversity: exploring dynamics of change” focuses on perspectives from in-service teachers who engaged in an action-oriented teaching initiative on biodiversity conservation proposed by a national environmental NGO. The study highlights the dynamics that shape teaching processes, and the underlying tensions involved when integrating more action-based approaches for biodiversity conservation within formal school settings. Study 2: “Building action competence through action-oriented sustainability teaching in biology teacher education” presents a university course for pre-service teachers in biology and provides perspectives from course participants. In the course, the pre-service teachers explore local possibilities, contact relevant stakeholders (e.g., municipalities), and plan action-oriented teaching approaches within this local context. The study shows how the course affected pre-service teachers’ perspectives for action-oriented teaching and which challenges remain. Study 3: “Collaborating with external stakeholders: Opportunities and challenges for biodiversity action” presents the perspectives of external stakeholders involved in a project focusing on biodiversity teaching and urban greenspace transformations for biodiversity. These stakeholders include the municipality, a public housing agency, and two educational networks supporting teachers. This study will show which opportunities and which challenges these stakeholders see to collaborate with schools in action-oriented learning approaches. Reference list Boeve-de Pauw, J., Olsson, D., Berglund, T., & Gericke, N. (2022).

Teachers' ESD self-efficacy and practices: A longitudinal study on the impact of teacher professional development. Environmental Education Research, 28(6), 867–885. Duifhuis, P., van Dijk, G., & Savelsbergh, E. (2025). Pre-service science teachers' visions on education for sustainable development – tensions, underlying beliefs, and experiences. International Journal of Science Education, 1-22. Sinakou, E., Donche, V., Boeve-de Pauw, J., & Van Petegem, P. (2019). Designing Powerful Learning Environments in Education for Sustainable Development: A Conceptual Framework. Sustainability, 11(21), 5994. Discussant in the symposium: Jelle Boeve-de Pauw

Collaborating with external stakeholders: opportunities and challenges for biodiversity action

Peter Lampert, Teresa Berglund and Niklas Gericke

| Symposia | 7: Lampert: Action-Oriented Teaching for Biodiversity: Exploring Dynamics of Change

Keywords: *Sustainability, Biodiversity, Action-Oriented Education, Stakeholders, Action Competence*

Submission #: 176

Biodiversity loss is a key environmental issue and highly relevant for biology education. Theoretical teaching approaches for biodiversity loss are insufficient, since gaps between theoretical knowledge and real world actions often persist. On the contrary, action-oriented teaching approaches can support learners in taking own real-world actions. To facilitate real-world actions for biodiversity going beyond individual efforts, collaborations with other stakeholders are necessary. The presented study therefore investigates the perspectives of relevant external stakeholders. The study explores perceived possibilities and obstacles for working together with schools to facilitate action-oriented learning about biodiversity to support real-world actions. For this purpose, ten guided interviews were conducted with three main groups of stakeholders: municipality (owning green spaces at schools and public parks) (5), housing agency (owning large housing areas where many school students and university students live) (3), educational networks (support schools) (2). Interviews were analyzed using thematic analysis, which resulted in three major findings: First, external stakeholders see a high potential in collaborating with schools to facilitate changes of green spaces and other biodiversity actions. Second, stakeholders highlight some challenges, such as a lack of prioritizing biodiversity as a major topic. Third, social norms regarding green space management and security aspects are a challenge. Considering aesthetical perspectives, giving cues to care, and informing people were key success factors in the project to overcome these challenges. In summary, the study shows a high potential for collaborations between schools and external stakeholders to facilitate action-oriented learning that is currently underexplored and needs specific support. This presentation is part of the symposium "ACTION-ORIENTED SUSTAINABILITY TEACHING: STAKEHOLDER PERSPECTIVES ON OPPORTUNITIES AND CHALLENGES"

Serious games for climate action: opportunities & challenges of digital game-based learning for biology teachers

Sarah Lang and Lena von Kotzebue

| Poster |

Keywords: *Digital Game-Based Learning (Dgbl), Serious Games, Technological Pedagogical Content Knowledge, Teacher Professionalization, Education For Sustainable Development (Esd)*

Submission #: 207

Climate change represents one of the most pressing global challenges, and education is considered a key factor in addressing it. Mere knowledge transmission is viewed as insufficient, and digital game-based learning (DGBL) offers a promising approach to bridging this gap. In the context of Education for Sustainable Development, digital climate games can convey complex interrelationships, reduce psychological distance, and promote environmentally responsible behavior. Teachers play a pivotal role in this process, as their attitudes, experiences, and competencies shape the integration of DGBL in classroom practice. This study surveys (prospective) biology teachers in Austria using a mixed-methods questionnaire: TPACK (Technological Pedagogical Content Knowledge) and Theory of Planned Behavior are extended by game-related components and take into account technological, pedagogical, and subject-specific didactic knowledge. The instrument is designed to capture relevant teaching-related aspects of DGBL, including teachers' attitudes, experiences, beliefs, and competencies. Qualitative data are collected on challenges in classroom implementation as well as on the requirements for effective DGBL. The aim of the analysis is to derive measures for teacher education and professional development, and to identify the potentials, challenges, and preferred design principles that biology teachers associate with the use of DGBL for climate education. Additionally, the study will contribute to the development of a serious game (impacts of climate change on biodiversity) designed to meet the needs of teachers and to provide a sustainable and low-threshold educational tool.

Evaluating the impact of e3d eco-labeling on primary school students' action competence for sustainability: a pilot study

Frederic Leterme, Jérémy Castéra, Magali Coupaud, Corinne Jégou, Carine Boyer, Nathalie Topalian, Solenne Albertini and Pierre-Olivier Thebault

| Oral |

Keywords: *Education For Sustainable Development, Action Competence, Eco-Labeling*
Submission #: 11

This pilot study evaluates the impact of the E3D eco-labeling on primary school students' action competence for sustainability. Emerging in the 1990s, Eco-Schools aim to promote sustainable practices within educational settings, with E3D being a notable French label managed by the Ministry of Education. Although sustainability-focused schools have been explored in several European countries, their effects in France have not been systematically examined. This research investigates the early effectiveness of E3D labeling in fostering students' latent capacity to act sustainably, operationalized through the Self-perceived Action Competence for Sustainability (SPACS) questionnaire. The study sample includes 179 fifth-grade students from five Marseille schools with varying social position index (SPI) scores, including one low SPI school labeled E3D. Adapted SPACS questionnaires were administered, and confirmatory factor analysis (CFA) supported the three-factor structure of action competence: knowledge of action possibilities, confidence in one's influence, and willingness to act. The data revealed confidence in influence as the least developed component across schools. Comparative analysis between schools with low and high SPI indicated comparable action competence scores, suggesting that E3D labeling may help low SPI schools achieve similar sustainability competencies to their higher SPI counterparts. However, the absence of a low SPI non-labeled control group limits definitive conclusions. The findings advocate for the potential of eco-labeling to reduce socioeconomic disparities in sustainability competence development among students and emphasize the need for further longitudinal research to validate these preliminary outcomes.

A self-regulated learning support model integrating internal and external pedagogical sensors to foster metacognitive awareness in open inquiry-based biology learning

Miri Levy, Pirchi Waxman, Efrat Link, Shoshi Herman, Irit

Sadeh and Michal Zion

| Poster |

Keywords: *Self-Regulated Learning (Srl), Open Inquiry-Based Learning, Metacognitive Awareness*

Submission #: 151

This study examines the contribution of an integrated Self-Regulated Learning SCAFfolds Framework (SRL-SCAF) support model to support metacognitive awareness among high school biology students engaged in open inquiry-based learning. The model combines internal and external pedagogical sensors that function synergistically to enhance students' regulatory processes. Learning diaries serve as internal sensors, enabling students to recognize and regulate their metacognitive awareness, while pedagogical teachers' simulations act as external sensors, enabling teachers to develop their ability to detect and respond to students' metacognitive awareness signals in real time. The study involved 373 students from 54 public high schools in Israel, divided into an experimental group (SRL-SCAF, N = 179) that received structured support through learning diaries and teachers' pedagogical simulations, and a control group (N = 194) that participated in open-based inquiry without targeted support. Quantitative findings revealed significant gains in declarative and procedural knowledge and across all components of metacognitive regulation of cognition - planning, process management, monitoring, debugging, and evaluation-among students in the experimental group. No significant improvement was found in conditional knowledge. Qualitative analyses of learning diaries and teachers' reflections reinforced these findings, illustrating how the pedagogical sensors facilitated the development of metacognitive awareness, autonomous learning, and a supportive learning environment. The integrated SRL-SCAF model emerges as an innovative dual-sensor framework that bridges students' internal self-regulation processes with teachers' adaptive support, advancing both theory and practice in fostering SRL within the open inquiry-based learning process.

“they felt seen in that moment”: exploring biology teachers’ understanding of third space pedagogy

Wilton Lodge, Alistair Newall, Michael Reiss and Emma Newall

| Poster |

Keywords: *Culturally Responsive Pedagogy, Third Space Theory, Biology Teaching*
Submission #: 32

Abstract As classrooms in Global North countries become increasingly diverse, there is increased need for science education to respond to the plurality of students’ lives. However, school science curricula often remain anchored in narrow, Western-centric worldviews, potentially alienating students with different knowledge systems, values, and experiences. This research investigates how secondary biology teachers in England understand and navigate this tension. We position biology as a subject that is of particular interest due to its large number of points of intersection between cultural and scientific views. Specifically we are interested in how biology teachers understand and use culturally responsive pedagogy to negotiate this complex educative landscape, and what kinds of supports or constraints shape this. We have used Third Space Theory, which acts to create hybrid environments that legitimise multiple epistemologies, as a lens through which to analyse semi-structured interviews with biology teachers in England. Findings emerging from our study indicate that teachers often use third spacing deliberately and proactively as a way of mediating between cultural and scientific viewpoints, although at the same time they also find themselves needing to respond in real time to emerging classroom situations. In doing this, teachers need to be aware of the pedagogical complexity and ethical sensitivity required to negotiate these tensions successfully. This negotiation, in which students’ lived experiences are leveraged as resources for learning, is seen as beneficial for both students, in terms of increasing engagement, and also for teachers as being personally and professionally enriching.

Integrating bioart into science teacher education: bridging science, creativity, and sustainability

Stiina Lõhmus and Anne Laius

| Poster |

Keywords: *Bioart, Science Teacher Education, Science–Art Integration, Creativity, Sustainability Education*

Submission #: 196

In recent years, the convergence of science and art has emerged as a promising pathway for educational innovation. Bioart – artistic practice employing biological materials and processes – creates opportunities to merge scientific inquiry with creative expression. This study investigates how future science teachers perceive, understand, and respond to Bioart as part of their professional development. A mixed-methods design was employed with pre- and post-questionnaires administered to Bachelor's students (n = 37 pre; n = 39 post) enrolled in a Science Teacher Education programme across disciplines including Biology, Chemistry, Geography, Physics, Mathematics, and Informatics. Data were analysed descriptively and thematically. Findings reveal significant conceptual and attitudinal shifts. Before participation, most respondents viewed Bioart as "living art" or "art made with biology." After engaging in Bioart-related learning activities, they described it as "a creative connection between ethics, science, and art," indicating enhanced cognitive understanding and reflective awareness. Ratings for interdisciplinarity, creativity, and collaboration increased notably, while mentions of sustainability and ethical responsibility doubled. Qualitative responses evolved from short, uncertain definitions toward integrative, value-oriented reflections emphasizing ecological awareness, creativity, and empathy. Approximately half of participants expressed readiness to incorporate Bioart-inspired activities into future teaching. Overall, Bioart functioned as an effective STEAM pedagogical model, strengthening interdisciplinary thinking, ethical reflection, and sustainability-oriented values. Integrating Bioart into teacher education can foster scientific literacy enriched by aesthetic, ethical, and environmental sensitivity – supporting future teachers in bridging scientific understanding and creative, responsible citizenship.

Why don't they get it? identifying and explaining slow spots in explanation progress

Francois Lombard, Sudriès Marie, Larpin Camille and Weiss Laura

| Oral |

Keywords: *Student Explanations, Slow Spots, Causal–Mechanistic Reasoning, Threshold Concepts, Conceptual Dependencies*

Submission #: 48

Teachers often face the same student difficulties year after year: despite clear explanations, some ideas remain persistently misunderstood. These recurring problems can be viewed not as failures of teaching or motivation, but as visible effects of underlying learning processes. This study stems from a long-term design-based research programme on students' written explanations in biology. Rather than classifying learners by misconceptions or hypothetical mental models, we analyse empirical traces of understanding as they emerge during learning—evidence that can inform teacher intervention when it is most useful. Using methods that map student explanations to reference learning goals, we identify slow spots—points where learning progress temporarily stalls despite continued instruction. To interpret these moments, we draw on two complementary frameworks: Conceptual Dependencies (CDs), grounded in Cognitive Load Theory and describing situations where understanding one concept depends on prior mastery of another, and Threshold Concepts (TCs), transformative ideas that reorganize understanding but are often difficult to master. Findings from three representative examples illustrate the heuristic power of this approach. In each case, slow spots mark developmental transitions rather than mere gaps—moments when conceptual load exceeds working-memory capacity or when a threshold is being approached. These analyses suggest how teachers might recognise and respond to such moments during learning, providing formative feedback before misconceptions solidify. Rather than offering generalizable results, this research demonstrates how identifying and interpreting slow spots through CD and TC lenses can bridge theoretical insight and classroom practice, supporting more responsive teaching and deeper mechanistic reasoning in biology.

Causal problems in everyday lay reasoning: connecting goals of use with information types

Abigail London and Michal Haskel-Ittah

| Oral |

Keywords: *Causal Mechanistic Reasoning, Public Engagement, Lay Reasoning, Explanations*

Submission #: 87

Science education should support laypeople's ability to reason about biomedical evidence in everyday contexts, recognizing that understanding the problems they seek to solve is essential, as different problems require different types of information. Therefore, we employed a novel theoretical framework connecting four causal problems (inference, explanation, prediction, and control) with two types of information: difference-makers (DM) (relations between cause and effect) and mechanistic (processes linking them). The study aimed to explore lay engagement with these four causal problems and their intuitive alignment between the goal and the information type, using the extreme situation of coping with cancer. Two studies were conducted: the "Forums study" analyzed 120 posts from online oncology forums, coding 80.7% of questions as causal, and the "Cancer patients study" which conducted semi-structured interviews with patients, who chose between receiving DM-like or mechanistic information. Findings affirmed that practical goals, Control and Prediction, are substantial drivers for seeking scientific information. However, epistemic goals (causal inference and causal explanation), were also prominent. The patient study demonstrated intuitive alignment between the goal and the information type preference: e.g. DM-like for Prediction and mechanistic for Explanation. Framing laypeople's engagement using the four causal problems is valuable for exploring and classifying their objectives. We suggest that science education should cultivate engagement with both DM and Mechanistic epistemic activities, underscoring their specific and complementary purposes.

Building microscopes, building capacity: reverse innovation for sustainable science education

Betina Lopes and Fredson Delgado

| Poster |

Keywords: *Microscopy, Sustainable Practices, Reverse Innovation, Teacher Professional Development, International Cooperation*

Submission #: 253

This study explores the potential of sustainable microscopy as a strategy for strengthening teacher professional development within the framework of reverse innovation. In low-resource contexts such as Cabo Verde, the scarcity of laboratory equipment creates both constraints and opportunities for frugal, creative, and locally grounded science education. In this South–North collaboration, 24 biology teachers engaged in a two-day, development programme where they built functional microscopes using recycled and locally sourced materials. This hands-on construction process enabled teachers to explore optical principles, test their devices with biological samples, and reflect collectively on the pedagogical implications of producing laboratory materials in resource-constrained settings. Drawing on data from pre- and post-course questionnaires, semi-structured interviews, field notes, and photographic documentation, a qualitative case-study design supported by thematic analysis was used to examine teacher learning and perceptions of sustainable laboratory practice. Findings indicate that constructing microscopes increased teachers' scientific confidence, improved their understanding of microscopy concepts, and fostered a sense of empowerment grounded in material autonomy. The Cabo Verde model highlights a replicable approach that can inform European professional development initiatives seeking resource-light and environmentally responsible practices in science teaching.

Upper secondary students' views of sexuality education

Mats Lundström

| Poster |

Keywords*: Sexuality Education, Views Of Content, Upper Secondary School, Online Survey*
Submission #: 56

This paper discusses Swedish upper secondary school students' views of what is important to cover in sexuality education. The aim of sexuality education is, among other things, to contribute to sexual health. Previous studies have mainly investigated teaching by means of observations and interviews. In essence, these studies have found that teaching often focuses on issues related to the body, such as puberty, pregnancy and sexually transmitted infections. In this study, questionnaires are used instead. The survey was conducted at an upper secondary school in Sweden. Students were asked to indicate on a four-point Likert scale how important they think different issues in sexuality education are. The questions were divided into seven themes. The results show that the students considered issues related to legislation and communication to be most important. On the other hand, issues related to identity and media were considered less important. The results also show that girls considered all themes more important than boys. The reason why legislation was considered most important may be the focus on consent and abuse in the public debate, but also the fact that sexuality education is now referred to as sexuality, consent and relationships in the curriculum. The results raise thoughts about how sexuality education can take into account both what students consider important and what is stated in curricula. One such issue is identity, which is given a lot of space in the Swedish curriculum, while students considered it to be the least important theme.

Teaching strategies and theories in school-based sleep education programmes – a literature review

Florian Macke and Anna Beniermann

| Poster |

Keywords: *Sleep Health Education, Teaching Strategies, Health Literacy, Literature Review*
Submission #: 147

Sleep plays a key role in maintaining human health. Insufficient and poor-quality sleep can lead to adverse health outcomes such as an increased risk of chronic diseases or impaired cognitive functioning (Touitou, 2013). Adolescents are particularly vulnerable to these risks due to shifts in their circadian rhythm during puberty: among other factors, early school start times combined with late-night activities and increased media use (Gruber et al., 2014) can negatively influence sleep duration and quality. Systematic reviews (Gaskin et al., 2024; Rigney et al., 2021) show that current school-based sleep education programmes increase knowledge of sleep and sleep health practices but often fail to produce lasting behavioural change. This raises the question of how the educators in these studies designed their instructional approaches and what teaching strategies they employed. This literature review revisits the studies examined by the aforementioned systematic reviews on school-based sleep education programmes (n = 37) using qualitative content analysis. It maps teaching strategies and their theoretical and didactic underpinnings that were applied. The dataset will be expanded to include studies from 2023 to 2025 by replicating the search strategies applied in the systematic reviews. Preliminary findings suggest that most studies only make limited reference to educational or behavioural theories that could inform their programmes. Furthermore, studies provide minimal – if any – information on their didactical and methodological rationale, thereby undermining the potential of science education theories and approaches to facilitate lasting behavioural change, and thus healthy sleep practices among adolescents.
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Teaching methods used in the university botanic gardens ljubljana

Katja Malovrh, Maja Tomšič, Blanka Ravnjak and Jože Bavcon

| Poster |

Keywords: *Botanic Gardens, Informal Learning Environment, Outdoor Education, Teaching Methods*

Submission #: 62

The University Botanic Gardens Ljubljana has been providing education since its very beginnings in the distant year 1810. The methods of education have changed over the years. It all started with plant species labels, later followed by lectures for students. Over the past 40 years, the garden has also been actively educating the general public and younger audiences. Initially, knowledge was shared through presentations of specific plant species, later through guided tours of the garden, the use of worksheets and other teaching aids as workshops, informational panels, lectures, fieldwork, online content, and external promotional events. During guided tours, various teaching methods and forms were used. We reviewed the programs we offer and evaluated the frequency of use of individual teaching methods and forms. Among the teaching methods, explanation and observation prevail, while the most common teaching form is frontal instruction. More than two-thirds of school groups choose guided tours that include the use of worksheets. It has been found that adults, as well as secondary schools and gymnasiums, more often choose general tours and topics that do not include practical workshops. Primary schools, especially lower grades, prefer more hands-on approaches. Kindergartens also mostly select programs that involve active participation of children or experiential tours that emphasize the use of senses. Based on this, we can conclude that the botanic gardens, with its living material (plants and animals), provides a practical learning experience and, as such, represents an important outdoor classroom.

Measuring tpack competence

Max Mannsperger, Sonja Schaal and Steffen Schaal

| Poster |

Keywords: *Tpack, Digital Competence, Vignette Test, Edr*

Submission #: 259

Teaching biology requires visualising complex, unobservable processes. Digital technologies (DT) offer pedagogical potential in digital–analogue learning paths, but effective integration demands high TPACK. Existing TPACK measures rely mainly on self-reports, not on assessing teachers' informed pedagogical decisions regarding DT use. This PROJECT aims to train biology teachers to design digital–analogue learning paths, fostering their TPACK. We address the lack of suitable assessments by developing a novel, vignette-based competence test for measuring technology integration decision-making, grounded in the PIC-RAT model. Using an Educational Design Research (EDR) approach, we iteratively developed the training course and the assessment tool. The vignette test, featuring comic-based scenes, was refined through expert reviews and student interviews. External validity will be established by comparison with the concurrently administered TPACK-Kurz survey. Initial feedback showed original questions lacked focus on media integration. Subsequent revisions - adding descriptive text and targeted questions - now elicit clearer, reflective responses. This project will yield a validated, reliable instrument to effectively measure and foster the competence necessary for well-founded integration of digital technology in science education.

The role of personal engagement in scientists' didactic transposition of biological knowledge

Daniel Manzoni-de-Almeida

| Oral |

Keywords: *Training Of Science Teachers In Biology, Identity And Didactic Transposition In Biology Teaching, Autoethnographies And Biology Teaching*

Submission #: 84

Here, in this study, I investigated the relationship between personal engagement and didactic transposition processes among scientists in pedagogical training, especially in the emergency context of the COVID-19 pandemic. Studies point to persistent difficulties in integrating scientific knowledge produced at universities with teaching practices in basic education, particularly when researchers migrate to teaching. Didactic transposition, understood as the transformation of scientific knowledge into teachable content, requires conceptual mastery, contextual adaptation, and accessible communication, dimensions influenced by the personal and social involvement of teachers. The research, which took a qualitative approach, was conducted between 2022 and 2024 as part of the "Science Education and COVID-19" workshops, involving 21 postdoctoral students in the biological sciences. The study comprised three stages: (1) a pre-workshop with a diagnostic questionnaire on teaching experiences and personal perceptions; (2) hybrid workshops organized in five sessions, focused on the development of research-based teaching sequences; and (3) production of autoethnographic narratives by two authors of completed chapters. The sequences and narratives were analyzed by categories derived from didactic transposition and identity engagement models. The results of the analysis of this case showed weaknesses in the participants' pedagogical training, especially with regard to inquiry-based teaching and the production of teaching materials. The analyses showed that greater personal engagement favors more contextualized and reflective transpositions, while limited engagement results in technically correct but insignificant approaches. It is concluded that the intensity of identity engagement is decisive for the quality of didactic transposition and can guide proposals for the training of scientist-teachers.

Understanding teacher trainees' critical choices in applying inquiry-based learning activities in biology classrooms

Daniel Manzoni-de-Almeida and Patricia Marzin-Janvier

| Oral |

Keywords: *Inquiry-Based Learning Biology, Science Teacher Training, Health Education*
Submission #: 83

Scientific literacy in the 21st century seeks to promote critical socio-political engagement with scientific issues. Inquiry-based learning (IBL) has proven to be an effective methodology for fostering this critical engagement, allowing students to understand the nature of science and analyze socio-scientific controversies. To this end, continuing education for teachers is essential, so that they can deal with sensitive issues and develop teaching sequences based on IBL and critical pedagogy. What are the main critical decisions mobilized by teachers in training in the process of implementing IBL? This study aimed to characterize the critical engagement of teachers in training during the evaluation of IBL teaching sequences in the context of biology education. Here, we had adopted a descriptive qualitative approach, using the course "Teaching Science and Human Rights," offered in the MEEF master's program at the Université de Bretagne Occidentale, France. The activity analyzed consisted of evaluating three IBL proposals on COVID-19 vaccines, ranging from confirmatory research to open-ended research. The responses of the 18 participants were categorized into five types of engagement: cognitive, pedagogical/didactic, epistemological, affective/emotional, and contextual. The results indicated that the students' initial choices were based mainly on affective and motivational aspects, followed by cognitive dimensions. However, when asked to propose improvements and justify their choices, the participants mainly mobilized pedagogical-didactic and epistemological engagements. It is concluded that critical engagement in IBL evolves from affective dimensions to deeper pedagogical analyses as formative mediation is structured, reinforcing the importance of continuous and systematic teacher training in investigative practices.

Critical thinking criteria for managing media information on antibiotic resistance

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Araitz Uskola

| Oral |

Keywords: *Critical Thinking, Critical Ignorance, Socio-Scientific Issues, Antibiotic Resistance, Media Literacy*

Submission #: 27

Critical thinking (CT) is essential to evaluate information related to socio-scientific issues (SSIs), such as antibiotic resistance (AR). Evaluating information critically and deliberately avoid mis-information is defined as 'critical ignorance', which has an impact on decision-making. The main goal of this work is to explore the criteria used by students for assessing credibility and expertise when dealing with information on AR before and after exposure to social media information. This study was developed with a group of 9th graders that engaged in the practice of CT in a learning sequence on AR that required managing information, and decision-making. The research questions are: 1) What are the criteria used to evaluate the credibility of AR information before and after exposure to social media?; 2) What are the criteria used to evaluate the expertise of the author before and after exposure to social media? Using multiple sources and expertise were the main criteria for evaluating credibility before, while only expertise remained as a remarkable criteria after exposure to social media. For expertise, academic career/experience was the main criteria before and after, but appearance and social media impact appeared after exposure to social media. The gap between the criteria before and after exposure highlights the importance of promoting CT. Further research will help to explore how credibility and expertise criteria influence 'critical ignorance' empowering students to take responsible actions on AR.

Fostering biodiversity data literacy using authentic data sets in biology education

Stella Mehl, Lars Dietrich and Kerstin Kremer

| Poster |

Keywords: *Data Literacy, Biodiversity, Design-Based Research, Big Data, Competencies*
Submission #: 228

In an increasingly data-driven world, the ability to critically collect, analyse, and interpret data is essential for active participation in society. Although Data Literacy is recognised as a key 21st-century competence, science classrooms still rely mainly on small, student-generated datasets and familiar tools such as spreadsheets. These activities offer limited exposure to the complexity and scale of authentic scientific data, leading to a narrowed understanding of how such data are produced, structured, and interpreted. Biodiversity research, which depends on large and heterogeneous datasets, presents a promising context for engaging students with authentic data practices. However, these datasets have rarely been systematically adapted for secondary biology education. This study addresses this gap by developing an authentic biodiversity dataset specifically designed to foster Data Literacy in secondary biology classrooms. Following a Design-Based Research approach, in the first design cycle, we created a large plant biodiversity dataset for Germany that integrates plant occurrence and abundance data with soil and weather variables. Because the initial dataset exceeded 300,000 cases, multiple filtering and sampling strategies were tested to enable use on standard school devices with CODAP. The resulting dataset contains roughly 5,000 cases representing five plant communities and associated environmental factors. Data explorations within this dataset enable students to investigate ecological relationships (e.g. how temperature or precipitation influence plant species richness) and to interpret patterns and trends. These activities promote central Data Literacy sub-competencies including data analysis, visualisation, and interpretation. The outcomes of this first design cycle provide a foundation for developing learning environments for different secondary levels and a qualitative study involving video-recorded interviews with student groups.

Mapping how esd competences are assessed in secondary education: implications for teachers

Marinthe A. Meijer, Jelle N.A. Boeve-de Pauw and

Marie-Christine P.J. Knippels

| Poster |

Keywords: *Education For Sustainable Development, Sustainability Competences, Assessment, Secondary Education*

Submission #: 115

Education for Sustainable Development (ESD) is increasingly emphasized in science education to equip students with competences for understanding and acting on complex challenges, such as biodiversity loss, climate change, and vaccination hesitancy. Despite growing attention in curriculum and pedagogy, less is known about how teachers can assess students' ESD-related competences (e.g. systems thinking, normative competence, informed decision making and action competence). Through literature review, we investigate current assessment practices in secondary science contexts, focusing on purposes of assessment (of, for, as learning), and their relevance for science teaching in general and biology teaching in particular. The methodology follows PRISMA guidelines; peer-reviewed studies on the assessment of ESD and related approaches, including Socio-Scientific Issue-based education and Problem-Based Learning, are screened. Only studies in secondary science education published between 2015 and 2025 in ERIC, Scopus, and Web of Science are included. Title-abstract-keywords screening was supported by the semi-automated tool ASReview, followed by manual full-text review. Analyses focus on how assessment evidence is collected (e.g., inquiry tasks, projects), interpreted (e.g., rubrics, quality criteria), and used to provide feedback and scaffolding. Data screening is ongoing, the review will identify patterns in assessment types, purposes, and practices supporting sustainability competences, highlight gaps in knowledge, and indicate areas for further research. Findings are relevant for biology teachers in particular and can guide the process of designing evidence-based assessments that integrate feedback, scaffolding, and real-world problem contexts.

If there is plant blindness – are we suffering from fungal forgetfulness?

Franziska Messenböck, Sonja Kletzer, Ulrich Hobusch,

Wolfgang Hinterdobler, Kerstin Kremer and Martin Scheuch

| Poster |

Keywords: *Fungal Literacy, Fungal Awareness Disparity Syndrome, Biodiversity Education*

Submission #: 237

Fungi constitute an immensely diverse kingdom with an estimated 6.2 million species, representing approximately 90% of terrestrial eukaryotic diversity and comprising 50% to 59% of all species on Earth. Despite their remarkable biodiversity and essential ecosystem functions—including nutrient cycling, decomposition, and symbiotic relationships with plants—fungi remain largely overlooked in educational curricula and public awareness. This neglect has significant implications for biodiversity conservation, sustainable development, and public health, as fungi play critical roles in supporting planetary health and enabling sustainable practices. Building on the concept of Plant Awareness Disparity (PAD), this study introduces Fungal Awareness Disparity Syndrome (FADS) as a parallel phenomenon describing the widespread lack of fungal awareness among the general public. FADS encompasses limited knowledge of fungal diversity, minimal engagement with fungal conservation issues, and insufficient recognition of fungi's ecological significance. Torres-Porras et al. (2025) documented that even individuals interested in mycology exhibit "fungal forgetfulness," highlighting lower comprehension of fungi compared to plants and animals, underscoring the need for targeted educational interventions. This study aimed to: (1) investigate existing knowledge gaps about fungi among individuals already interested in mycology, (2) evaluate understanding of fungi's ecological roles in ecosystems, (3) compare knowledge levels between self-identified experts and non-experts, and (4) establish baseline data to inform future educational interventions and curriculum development. The research was conducted at a specialized mycology festival in a major European city, attracting approximately 5000 visitors over a week-long period. The festival featured workshops, exhibitions, film screenings, and lectures from distinguished mycologists, providing barrier-free, multilingual access to fungal knowledge. A questionnaire design was employed to accommodate different expertise levels, with participants self-assessing their fungal knowledge on a six-point scale ranging from "no knowledge" to "very good." This methodological approach enabled comprehensive evaluation of fungal awareness across diverse audience segments, establishing critical baseline metrics for developing effective educational strategies.

Knowledge about and attitude towards bees in grades 4 and 8 of primary school

Dominika Mlakar, Jelka Strgar and Žan Rode

| Poster |

Keywords: *Bees, Knowledge, Attitude, Biology Classes, Extracurricular Activity*
Submission #: 123

The bees have an important role in pollination and food production. Research shows positive attitudes of people toward the bees but also fear of them. Our objective was to determine the attitudes and the knowledge concerning the bees of 372 students from grade four and eight of primary school in Slovenia. Data was gathered in 2024, using a questionnaire. Results show that Slovenian students possessed better knowledge about the biology of the bees than about the importance of the bees. 9-10-year-olds were more familiar with the biology of the bees, while 13-14-year-olds better understood the importance of the bees. In 9-10-year-olds, students' knowledge seemed to be more correlated with attitudes towards the bees than in 13-14-years-olds. These results indicate that some of the knowledge the students gained when 9-10-year-olds is forgotten in the following four years. Nevertheless, 13-14-years olds manage to develop a better understanding of the role that the bees have in the world, which is an important objective of the education according to the national curriculum.

Nature in swedish lower secondary biology: western hegemony or pluriversality?

Kate D. Molina-Gallo, Daniel Olsson, Teresa Berglund and

Niklas Gericke

| Oral |

Keywords: *Education For Sustainable Development, Coloniality Of Nature, Pluriversality*

Submission #: 69

Education for Sustainable Development (ESD) is inscribed in Swedish biology education steering policies. However, concerns are intensifying over the link between sustainable development and coloniality, and the role of education in the perpetuation (or disruption) of hegemonic thought. Through deductive text analysis using Arturo Escobar's model of coloniality of nature, we investigated how culture-nature hierarchies, nature-human dualism, and the commodification of nature are represented in the overall mission and values of the Swedish compulsory school curriculum, as well as subject syllabi and commentary material for primary natural sciences and lower secondary biology. Our analysis revealed that the curriculum includes very few decolonised conceptualisations of nature, including an ecocentric view of nature and the use of evolution to disrupt nature-human dualism. However, other goals reinforced an anthropocentric view of nature, such as ecosystem services, which is introduced to students as early as Year 4. Furthermore, the fundamental values of the school emphasise ethics centred on the Christian tradition and Western humanism, which have contributed to the development of hierarchies based on species and race and the capitalisation of nature. And while these interpretations of nature appear conflicting, they provide biology teachers an opportunity to incorporate the pluriversality in the classrooms, thus avoiding the perpetuation of Western thought as the only way to understand our world.

Science comics as interactive didactic resources: impacts on non-formal science education context

Marina Mota, Cristina Sá and Cecília Guerra

| Poster |

Keywords: *Research And Development, Science Comics, Science Communication, Informal Education*

Submission #: 144

This Research and Development (R&D) investigates the impact of three interactive didactic resources based on science comics in promoting scientific literacy among children aged 8-9 within a non-formal science education context. Grounded in the intersection of science communication and education, the research investigates how science comics – combining visual narratives and scientific content – can simplify complex health-related topics and foster engagement. The study employs Design Thinking (DT) to develop three interactive resources aligned with the Portuguese primary education curriculum and WHO public health themes, such as communicable diseases, nutrition, and safety. The resources were validated by a health researcher, a primary school teacher, and a storytelling expert to ensure scientific accuracy, educational relevance, and narrative appeal. Implemented in a science centre with 15 children, data were collected through observation, video recordings, and analysis of children's work. Findings revealed that science comics effectively engaged children, encouraging critical thinking and collaboration, simultaneously promoting language skills such as reading and writing skills. The study highlights the potential of science comics as an innovative resource for fostering scientific literacy in non-formal settings. It contributes to the emerging debate on the relationship between science communication and education, highlighting how interdisciplinary approaches can bridge these fields effectively. As an R&D investigation, this research offers insights for both theory and practice. Future studies should explore the development and implementation of science comics in formal and informal educational contexts while further refining their design through iterative feedback processes.

Pre-service biology teachers' views on using ai in their future profession: a pilot study

Jure Mravlje, Ana Pšeničnik and Iztok Tomažič

| Poster |

Keywords: *Pre-Service Biology Teachers, Generative Ai, Attitude, Self-Efficacy Beliefs, Competences, Teaching Strategies*

Submission #: 260

Generative AI (GenAI) is reshaping educational practice by enabling personalised learning, automating routine tasks, and enhancing accessibility. MagicSchool AI, a GenAI-powered tool based on large language models (LLMs), supports educators by generating content and streamlining lesson preparation. Despite its potential, responsible integration of AI in education requires critical awareness of its pedagogical implications and limitations. This study was a part of the Slovenian national project »Modernisation of pedagogical study programmes (2023–2026)« and explored pre-service biology teachers' attitudes and competences regarding AI. Sixteen students across two academic years (2023/2024 and 2024/2025) participated in a mixed-methods design embedded in the »Biological Practicum for Teachers« course. A pre-test and post-test questionnaire assessed affective viewpoints, perceived competences, acceptance, and self-efficacy related to the use of AI in teaching. Students engaged in AI-supported and teacher-designed lesson planning activities, followed by reflection and discussion. Findings revealed generational differences: second-generation students were more familiar with AI tools and showed higher initial belief ratings. However, first-generation students exhibited greater positive shifts in attitudes and confidence following the intervention. These results suggest that targeted educational activities can significantly enhance AI-related competences, especially among less experienced users. This study highlights the importance of teaching students to use AI creatively and purposefully, rather than limiting its role to summarisation. While the small sample size is a limitation, additional participants will be included in the 2025/2026 cohort. Ultimately, the research advocates for pedagogical strategies that empower future educators to integrate AI meaningfully into their professional practice.

Stem in austria: designing effective learning materials for a new school subject.

Carina Mur-Spiegl and Suzanne Kapelari

| Poster |

Keywords: *Stem Education, Material Development, Interdisciplinary*
Submission #: 270

In the 2022/23 school year, Austria launched a school trial in 57 secondary schools to introduce the interdisciplinary subject STEM (Science, Technology, Engineering, Mathematics). This new subject is intended to complement traditional, separate subject teaching by enabling the intertwining of disciplines. The goal of STEM instruction is to promote key skills such as critical thinking, problem-solving, and scientific curiosity. Pupils can work in a relaxed atmosphere because they face less time restriction and are not under pressure to achieve a certain grade. However, the interdisciplinary approach demands a high level of commitment from teachers, often requiring personal interest in subjects they did not study at university. To support the challenging implementation and evaluate the effectiveness of the school trial, it is being scientifically monitored. The accompanying project develops and tests materials designed to reflect the complex interconnection between subjects. Key research questions focus on how STEM teaching is organized in Austria, how materials should be designed for pupils to experience the interconnection and gain knowledge, and what support teachers require. The evaluation uses pre- and post-tests to measure knowledge gain, complemented by interviews with students regarding their motivation and the materials used in class. Preliminary findings from four classes indicate that the language used within the materials causes problems, particularly for students with a low German language level. It is evident that students are able to learn topics better when they trigger emotions, whether positive or negative. Furthermore, students expressed a desire to obtain information within their experiments instead of receiving prior input, an aspect already integrated into the materials for the 8th grade. The ongoing research helps to better understand the subject STEM and students' needs when learning interlocked subjects.

Framing action competence for climate change: insights from esd and applications in biology education

Arief Muttaqiin, Niklas Gericke and Daniel Olsson

| Oral |

Keywords: *Action Competence, Climate Change, Sustainability Education, Biology Education, Esd*

Submission #: 94

Biology education plays a strategic role in fostering students' action competence in addressing climate change issues. Responding to this need, through integrative review, this study introduces the ACi3C (Action Competence in Combating Climate Change) framework, which is built upon three core dimensions: knowledge of action possibilities (KAP), confidence in one's own influence (COI), and willingness to act (WTA). These dimensions aim to guide student in addressing climate-related challenges by integrating both direct and indirect climate actions. The KAP dimension encompasses four aspects: knowledge of issues, knowledge of actions, knowledge of values, and metacognitive capacities. The COI dimension comprises confidence in one's own ability (self-efficacy), confidence in group ability (collective efficacy), confidence in influencing decision-making (political efficacy), and confidence in the positive outcomes of action (outcome expectancy). The WTA dimension includes internal drives, socio-moral drives, and emotional drives. By integrating direct and indirect climate actions, ACi3C moves beyond cognitive learning toward empowering students for ecological engagement. In addition, this framework offers conceptual guidance for curriculum development, assessment design, and evaluation of sustainability-oriented learning, particularly within the context of biology education.

Teacher self-efficacy and the integration of 3d printing in science education

Zuzana Nedvědová and Lukáš Rokos

| Oral |

Keywords: *3D Printing In Education, Teacher Self-Efficacy, Science Education, Technology Integration, Design-Based Research*

Submission #: 155

3D printing technology is gradually entering schools, and its availability has increased in recent years. However, this does not automatically lead to its meaningful use in teaching; the key factor remains the teachers and their decision about whether and how to use the technology. Science teachers face a variety of technical and pedagogical considerations when incorporating 3D printing into their teaching, and teacher self-efficacy plays an important role in this process. This study examines how teachers perceive their competencies related to the use of 3D printing and 3D-printed models in science education, what benefits and barriers they identify, and what factors influence their decisions to adopt this technology. The research is based on a pilot questionnaire survey among Czech lower-secondary teachers (n = 211). The data reveal differences in self-efficacy among teachers with varying levels of technology experience, with the greatest uncertainty occurring in practical steps related to preparing and executing the print. Teachers also recognise several benefits, particularly the potential to support understanding of abstract concepts, increase student motivation, and foster more active participation. The survey findings are complemented by qualitative data from ongoing classroom observations and interviews with teachers who use 3D printing or 3D-printed models in their teaching. This qualitative phase offers insight into how teachers work with technology in practice and what they need for effective implementation. The findings also inform the initial design of a future professional development course aimed at strengthening teacher self-efficacy in using 3D printing.

Game-based learning of coastal ecology: an intervention study on the impact of gbl on students' intrinsic motivation

Emanuel Nestler and Carolin Retzlaff-Fürst

| Poster |

Keywords: *Game-Based Learning, Serious Game, Motivation, Design Based Research*
Submission #: 272

This study is part of a design-based research (DBR) project that develops a system combining a digital game with a flexible learning environment, grounded in Self-Determination Theory (SDT). We examine whether the system enhances students' intrinsic motivation when learning about human impacts on gull ecology. The intervention is a 90-minute biology lesson built around Seagull Swoop, a side-scrolling game that simulates gull foraging decisions and human influences in coastal environments. Game phases alternate with Think–Pair–Share activities in which students work on four task sets addressing subtopics such as fishing, waste and climate change. Students choose two of the four task sets, aiming to support autonomy within a structured lesson design. A comparison condition covers the same ecological content and uses the same social formats and time allocation, but omits the game so that any differences in motivation can be attributed to the game-based system. The quasi-experimental study was conducted in German comprehensive schools with (N = 122) students in classes assigned to either the game-based system or the comparison condition. Intrinsic motivation was measured using the KIM short questionnaire immediately before the lesson (pre), after the first half (mid) and at the end (post). Planned analyses include repeated-measures ANOVAs and, where appropriate, multilevel models with time nested within students and experimental condition as a between-subjects factor, while considering potential class-level clustering. A previous pilot study (N = 53) indicated a time × group interaction favouring the game-based system for interest/enjoyment. Data analysis of the extended sample is currently in progress. Preliminary descriptive patterns, considered together with the pilot findings, suggest that the system combining Seagull Swoop with structured collaborative tasks can foster students' situational interest and enjoyment during a single lesson, while patterns for perceived competence, perceived choice and pressure/tension are less clear and will be explored further. Within the DBR framework, these findings will be used to refine the alignment between game mechanics, task design and SDT needs, and to develop design principles for subsequent cycles that integrate species identification and ecological systems understanding into a scalable game-and-lesson system for biology classrooms.

Technology-related enacted beliefs in biology education: a methodological exploration of the plan-teach-reflect cycle

Marie Neumann and Benedikt Heuckmann

| Poster |

Keywords: *Beliefs, Technology, Videography, Rcm, Enactment*

Submission #: 169

Teachers' beliefs are a crucial component of professional competence and strongly shape the integration of digital technologies in instruction. Yet, research on technology-related beliefs has predominantly relied on self-report measures, capturing only explicit and often peripheral aspects of belief systems. This study addresses the need for approaches that access implicit, action-guiding beliefs by exploring the assessment of enacted beliefs within the Plan–Teach–Reflect (PTR) cycle. Following the approach presented by the RCM for PCK, which distinguishes between collective, personal, and enacted professional knowledge, we propose its applicability as a conceptual framework for systematizing enacted beliefs. This exploratory case study (n = 6) investigates how artifacts generated across the PTR-cycle (lesson plans, classroom video recordings, and stimulated recall interviews) can be used to identify prospective biology teachers' technology-related enacted beliefs. Using a category system for technology-related beliefs complemented by inductive coding, each artifact type was analyzed separately and subsequently triangulated with questionnaire data on stated beliefs. Findings from an illustrative case reveal a set of core technology-related beliefs consistently enacted in classroom practice, as well as peripheral beliefs expressed but not enacted. Approximately half of the enacted beliefs aligned with stated beliefs, highlighting both coherence and tensions between intentions and actions. Stimulated recall interviews proved particularly effective for uncovering implicit beliefs guiding instructional decisions. The study demonstrates that PTR-cycle artifacts provide complementary insights into belief enactment and offer a promising methodological approach for making pre-service teachers' belief systems visible. Implications for teacher education and avenues for further research are discussed.

Transforming climate representations: experiential tools in agricultural education

Asloum Nina, Murillo Audrey, Del Corso Jean-Pierre and

Gallai Nicola

| Oral |

Keywords: *Climate Change, Representations, Agricultural Education, Teaching Methods, Environmental Commitment*

Submission #: 61

This research falls within the field of conceptual change and climate change education, drawing on a collaborative approach between teachers and researchers from the LéA-Ifé DEFiCLIM program. The aim is to analyze how experiential teaching methods promote the transformation of representations and attitudes toward engagement among students in agricultural training. Based on the theoretical framework of conceptual change (Kuhn et al., 2000) and the challenges of science education (Lange & Martinand, 2010), it uses a mixed approach combining epistemological questionnaires and semi-structured interviews, exploring three dimensions: cognitive, affective, and behavioral. of 14 students from two French agricultural high schools (vocational baccalaureate programs: CGEA and SAPAT, BTS GPN and STAV baccalaureate). These data, combined with field observations, make it possible to assess the evolution of conceptions of scientific knowledge, attitudes toward climate change, and envisaged professional behaviors. The results show a gradual shift from a realistic view of knowledge to an evaluative stance that incorporates uncertainty and complexity. Three engagement profiles emerge: “pragmatic wait-and-seeers,” “proactive worriers,” and “pragmatic fatalists.” These results highlight the tension between ecological awareness and a sense of personal efficacy. The study highlights that experiential and collaborative activities—field visits, debates, collective projects—reinforce both scientific understanding and civic engagement. They thus serve as a lever for connecting the cognitive, emotional, and behavioral dimensions of learning, while offering avenues for rethinking the training of future agricultural professionals in the face of climate challenges.

Reducing misconceptions about natural selection: an intervention in upper secondary school

Jorun Nylehn, Ragnhild Gya and Kjersti Lea

| Oral |

Keywords: *Evolution, Natural Selection, Misconceptions, Intervention, Upper Secondary School*

Submission #: 173

Natural selection is a core topic in biology, with numerous known misconceptions even found at master's level in biology. We have developed and tested an intervention for upper secondary school, where explicit targeting of well-known misconceptions is included in structured group activities. The students are tested with a pre- and post-test design applying Conceptual Inventory of Natural Selection (CINS). After the intervention, the students that have completed the intervention scored higher than master students in biology on CINS. Although promising and interesting, our conclusion is that more research is needed. We have hitherto tested two classes, and we will include more classes as well as long-term effects. The intervention will also be tested in a workshop with practicing teachers in secondary school.

Addressing biomass misconceptions with systems thinking models in photosynthesis

Yılmaz Öden, Burcu Güngör Cabbar and Nazlı Ruya Taşkın

Bedizel

| Poster |

Keywords: *Systems Thinking, Photosynthesis, Misconceptions, Biomass, Sustainability*

Submission #: 99

Photosynthesis is a critical yet challenging topic for students, who often struggle with its conceptual foundations and hold persistent misconceptions about its role within ecosystems. A common misconception is attributing the increase in a tree's biomass primarily to nutrients absorbed from the soil. This study aims to improve students' understanding of the causal relationships between photosynthesis and biomass by using systems-thinking tools, enabling them to recognize underlying structures behind observable events and develop a more holistic perspective. Systems thinking is known to support higher-order cognitive skills and problem-solving abilities. Employing a qualitative case-study design, an 11-item instrument structured according to the Iceberg Model (observable events, behavior patterns, underlying structures) was administered to 22 high school and 22 university students in Balıkesir. In the initial phase, students' misconceptions about the source of biomass were clearly revealed. When students were later guided to construct the photosynthesis equation through prompts and mathematical reasoning, they calculated that over 90% of a tree's mass derives from carbon dioxide, a gaseous input. This discrepancy between their initial observations and scientific calculations triggered cognitive conflict, facilitating conceptual change. By the end of the activity, students emphasized photosynthesis and omitted soil contribution from their explanations, indicating a shift toward scientifically accurate reasoning. Although both groups produced similar drawings, high school students' written explanations demonstrated stronger scientific terminology. The findings suggest that systems-thinking approaches can effectively initiate conceptual change in biology education and should be integrated into instructional programs to foster deeper understanding of complex biological processes.

A theory of planned behavior approach to fostering pre-service biology teachers' use of digital incremental scaffolds

Margit Offermann, Nadine Großmann, Jörg Großschedl, Lea Gussen, Svea Isabel Kleinert, Ricarda Lohrsträter, Pascal Schaldach, Steffen Schaal, Rebekka Siedler and Matthias Wilde

| Oral |

Keywords: *Teacher Training, Online Training, Pre-Service Teachers, Theory Of Planned Behavior*

Submission #: 81

Teaching heterogeneous student groups poses major challenges for biology teachers. Incremental scaffolds represent a promising approach to support learners with different skills and knowledge by reducing cognitive overload and enhancing problem-solving skills. However, for students to benefit from incremental scaffolds, teachers must first acquire the ability to integrate them effectively into instruction. equip teachers with such skills, we designed a digital teacher training on digital incremental scaffolds. We based our research on the Theory of Planned Behavior (TPB), since it describes conditions under which teachers actually implement teaching methods. In the evaluation, we investigated the participants' attitudes, the perception of subjective norms, their self-efficacy, and their intention to use incremental scaffolds in biology education before and after the training. A total of 100 pre-service biology teachers (MAge = 23.4 years, SDAge = 3.5; 86% female) completed pre- and posttests. Paired-sample t-tests revealed significant increases across all TPB and TPACK constructs: attitude ($t(71) = 5.75$, $p < .001$, $d = 0.86$), subjective norm ($t(39) = 3.05$, $p < .01$, $d = 0.55$), self-efficacy ($t(98) = 8.89$, $p < .001$, $d = 1.33$), behavioral intention ($t(82) = 6.04$, $p < .001$, $d = 0.80$), and TPACK ($t(318) = 5.61$, $p < .001$, $d = 0.70$). All effects remained significant after Bonferroni correction ($\alpha = .01$). The strongest improvements emerged for self-efficacy and attitude, followed by intention and TPACK. These results indicate that the MOOC effectively enhanced participants' motivational and technological-pedagogical readiness to apply digital scaffolding strategies in biology lessons.

Development and validation of a nutrition questionnaire based on kap and hbm

Petra Olschewski, Helena Aptyka, Maren Flottmann, Corinne Wacker, Sandra Vamos and Kirsten Schlüter

| Oral |

Keywords: *Health Belief Model (Hbm), Kap (Knowledge - Attitudes - Practices) Framework, Questionnaire Development And Validation, Dietary-Related Health Behavior, Self-Efficacy*

Submission #: 74

In light of the rising prevalence of overweight, Type II diabetes, and cancer, dietary-related health education has gained growing importance. Consequently, research is increasingly focusing on preventive strategies, such as promoting healthy eating. To assess individuals' dietary health behaviors, various instruments have been developed. Widely used approaches refer to the Health Belief Model and the Knowledge, Attitudes, and Practices framework. Although the two approaches complement each other well, they have rarely been combined and have mostly been applied in very specific contexts. The aims of this study were therefore (1) to combine both approaches and create a general dietary-related and prevention-oriented questionnaire, and (2) to investigate correlations between the constructs based on a survey of future health educators. Based on a six-steps process, we created a 65-items questionnaire. The data analyses revealed the strongest correlations between perceived benefits of a healthy diet and the threat of an unhealthy one ($r = .46$), as well as between self-efficacy and external barriers ($r = -.42$). Students perceiving more external barriers also reported more internal barriers ($r = .38$). Regarding healthy eating behavior, self-efficacy ($r = .35$) and external barriers ($r = -.33$) emerged as key factors, while internal barriers showed no significant association with healthy eating behavior ($r = -.17$), but with self-efficacy ($r = -.38$). The findings confirm existing and well-established correlations (e.g., between self-efficacy and external barriers with behavior) while additionally highlighting new aspects, such as the correlation between internal barriers and self-efficacy, but not with behavior.

Enhancing photosynthesis literacy in secondary education: evaluating a framework-based teaching design

Daniel Olsson, Anders Eriksson and Niklas Gericke

| Oral |

Keywords: *Photosynthesis Education, Secondary School, Scientific Literacy, Effect Study*
Submission #: 65

Photosynthesis education is frequently regarded as abstract and difficult to grasp. To address these challenges, the Photosynthesis Literacy Framework was developed with two main objectives: reducing students' learning difficulties and enhancing relevance by connecting photosynthesis to societal and sustainability issues. This study evaluates the impact of a teaching design grounded in this framework, compared to traditional instruction. Using a mixed-method approach, we collected quantitative pre- and post-test data from both experimental and control groups, alongside qualitative classroom observations and student interviews within the experimental group. Thematic analysis of qualitative data identified pedagogical features that supported students' development of photosynthesis literacy. Results indicate that the framework-based design significantly improved students' literacy across most dimensions, particularly in scientific understanding. Four key features contributed to its effectiveness: authentic experiences, active participation, wonder and fascination, and collaborative work. We recommend this teaching design for diverse educational contexts to foster meaningful and effective learning in photosynthesis education.

Culturally responsive pedagogy in climate science education: empowering student voices

Kathrin Otrel-Cass, Joey Guercio, Iris Mendel, Michael Reicho, Annika Heher, Michaela Frieß and Thomas Kosel

| Symposia | 2: Dillon: Culturally Responsive Biology Education

Keywords: *Culturally Responsive Pedagogy, Community, Care, Student Voice*

Submission #: 275

This research looks at how culturally responsive pedagogy can be used in climate science education in secondary school. It uses the ongoing "Stories from the Future" project conducted at an Austrian secondary school and looks at how students understand science when the teaching style considers their voice and that of their communities. The study worked with three secondary school classes. It used classroom observations, student artefacts and research journals. These showed how students investigated climate topics that were important to them. These topics included snow, water level changes, air pollution and the connection between food and climate. The study reveals five main findings: 1) investigations based on place made abstract climate concepts easier to understand; 2) different ways of doing things made it easier to understand science; 3) multilingual resources helped students to understand concepts better; 4) critical inquiry into environmental justice connected personal experiences to bigger problems; and 5) community knowledge enriched the students' scientific investigations. The research shows that climate education needs to move away from teaching facts that have no connection to students' lives. It should be based on teaching that connects with their lives and recognises their cultural and linguistic strengths. Students should be recognised as important contributors to the curriculum. Our recommendation includes also that assessment practices should value different ways of demonstrating understanding in science and that teaching climate science in caring ways should be based on reciprocal relationships between schools and the community.

Main: learning to care: transforming biology education through biodiversity awareness

Peter Pany and Dawn Lorraine Sanders

| Symposia | 6: Pany: Learning to Care: Transforming Biology Education through Biodiversity Awareness

Keywords: *Biodiversity Awareness, Biodiversity Education, Sustainability Education, Action Competence, Art-Based Science Education*

Submission #: 130

The accelerating loss of biodiversity represents one of the most complex and urgent challenges of the twenty-first century. Biodiversity underpins ecosystem functioning and forms the ecological, cultural, and economic foundations upon which human well-being depends (Cardinale et al., 2012). Despite this fundamental importance, global assessments continue to report unprecedented rates of species extinction and ecosystem degradation driven by anthropogenic pressures (habitat destruction, climate change, and pollution; Cardoso et al., 2020). Although the biodiversity crisis demands immediate societal attention, biology education still lacks a coherent conceptual framework and effective pedagogical tools to understand, measure, and teach biodiversity awareness. This gap hampers our ability to prepare learners to engage and act for conservation (Pedrera et al., 2021). To address this challenge, the symposium proposes a research-based educational approach to biodiversity awareness that unites cognitive, affective, and action-oriented dimensions of learning. As Reiss (Reiss, 2020) provocatively asks, “Do we want biology courses […] also to shape students’ attitudes and behaviours? Do we want students […] to care about this?” (p. 46). Building on this call, the symposium seeks to explore how innovative concepts, methodologies, and learning environments can transform biodiversity education into a force that actively “paves the way for our common future.” The four contributions illustrate complementary pathways toward such transformation. The first examines wonder as a foundational affective dimension of plant awareness, drawing on Goethean perspectives and presenting indicators that capture aesthetic, moral, symbolic, and naturalistic connections with plant life. The second, Miniature Landscapes, demonstrates how art–science practices in preservice teacher education can refine visual perception, cultivate curiosity, and promote meaningful encounters with overlooked organisms through hands-on engagement with natural materials. The third addresses persistent conceptual hierarchies in how students understand “what is alive,” revealing entrenched animistic and anthropocentric biases and offering diagnostic tools to broaden learners’ recognition of life across all kingdoms. Finally, the BiodiverCITY-Islandhopping project presents a longitudinal, action-competence based intervention that engages secondary students as citizen scientists, promoting positive attitudes toward insects and plants and strengthening their capacity for biodiversity-related action. Together, these contributions offer a multifaceted perspective on how biology education can cultivate awareness, empathy, perception, and agency – key capacities for enabling learners to participate in shaping a biodiverse and sustainable future.

Through this symposium, we aim to respond to that challenge by fostering international dialogue on how conceptual, methodological, and pedagogical innovation can reframe biology education as a transformative force for sustainability. Discussant: Alexandros Amprazis

Teaching and learning evolution in early childhood education: a mapping literature review

Penelope Papadopoulou, Alexandros Amprazis and Despina Tsopoglou-Gina

| Symposia | 5: Pessoa: EVOLUTION EDUCATION IN THE EARLY YEARS

Keywords: *Biological Evolution, Early Childhood Education, Mapping Literature Review, Preschool Children, Teachers*

Submission #: 60

Evolutionary theory is a cornerstone of biological understanding, yet research on how its core ideas can be introduced in Early Childhood Education (ECE) remains scarce. Engaging preschool children with foundational evolutionary concepts fosters inquiry skills central to scientific reasoning. However, effectively teaching this content requires well-prepared teachers who combine solid scientific understanding with developmentally appropriate teaching strategies. This systematic mapping review aims to record and analyze existing research on the teaching and learning of evolutionary theory in ECE, identifying thematic trends, methodological approaches, and gaps in current scholarship. Following the mapping review methodology, the search was planned for Scopus, ERIC, and PsycINFO; however, this paper reports preliminary results based solely on Scopus. After applying inclusion and exclusion criteria, 20 studies were retained and categorized into three research lines: (1) preschool children's potential for understanding evolutionary ideas, (2) teachers' knowledge, attitudes, and acceptance of evolution, and (3) curriculum development and use of educational resources. The findings indicate that relevant research emerged mainly after 2010 and remains limited, focusing largely on small-scale qualitative or mixed-method studies. While early findings show promising educational outcomes, the field requires further expansion—particularly concerning teacher education and readiness to teach evolution in preschool settings. This mapping review contributes to identifying current knowledge gaps and supports the development of future research directions for integrating evolution into early science education.

Drawings of microorganisms by preschool students: design of an analysis rubric and comparison between human and artificial intelligence evaluations

Jessica León Paredes, Cristina Valares Masa, Jesús Gómez Ochoa de Alda, María Rocío Esteban Gallego and José María Marcos Merino

| Poster |

Keywords: *Early Childhood Education, Children'S Drawings, Rubric Validation, Microbiology Education, Artificial Intelligence*

Submission #: 52

Drawing is a powerful tool in Early Childhood Education to access children's ideas, emotions, and conceptions before they master oral language, providing insights into cognitive and emotional development. However, the lack of validated instruments for analyzing drawings limits their educational potential. This study aimed to design and validate a rubric for assessing children's drawings of microorganisms and to compare evaluations made by human experts and artificial intelligence (AI). Twenty-two children aged three participated by freely drawing a microorganism. Their drawings were assessed using a four-dimension rubric—Fine Motor Development, Representational Cognitive Development, Emotional Indicators, and Social/Self-Image—rated on a three-level scale. Five expert teachers and four AI instances evaluated the drawings, and data were analyzed for consistency and agreement.Results showed that the rubric successfully differentiated developmental levels. Drawings rated as "Needs attention" were schematic and monochromatic, whereas "Advanced" drawings displayed structural detail and expressive features, though often with negative depictions of microorganisms. Human evaluations demonstrated high internal consistency and inter-rater agreement, validating the rubric's reliability. In contrast, AI assessments were inconsistent and unreliable, particularly for affective and symbolic aspects, confirming that AI cannot yet substitute expert interpretation. The study concludes that the rubric is a valid and practical tool for educators to assess expressive and conceptual development and to detect early misconceptions about microorganisms. It also highlights that such misconceptions appear as early as age three and that while AI may assist in analysis, expert human judgment remains essential for meaningful interpretation

Exploring the support needs of teachers as facilitators in citizen science

Jelle Boeve-de Pauw and Bart de Groot

| Symposia | 1: Tsybulsky: Transforming Biology and Environmental Education through Citizen Science

Keywords: *Citizen Science, Facilitators, Support Needs*

Submission #: 163

Citizen science is increasingly promoted as a pedagogical tool capable of enriching science education, especially in biology and environmental science. Yet little is known about the specific needs teachers encounter when implementing externally designed citizen science projects into formal secondary (biology) education. Existing frameworks describing facilitator needs in citizen science were not developed with teachers in mind, raising the question of whether they adequately capture the realities of school-based facilitation. This study investigates the support science teachers require when integrating a large-scale environmental citizen science project ('Snuffelfiets', a Dutch initiative measuring particulate matter through bicycle-mounted sensors) into their classroom practice. Using semi-structured interviews with seven teachers, we explored their experiences along three domains of facilitator needs: core needs, operational needs, and engagement needs. Findings show that teachers, while confident in general classroom facilitation, face distinct challenges when acting as mediators between scientific research and novice student participants. Three overarching themes emerged: (1) teachers valued project-specific support, particularly regarding data handling and research literacy; (2) student recruitment and sustained engagement required different strategies in compulsory school settings versus typical voluntary settings; and (3) teachers emphasised the importance of connecting classroom participation to "the bigger picture" of scientific and societal relevance to motivate students in biology-related topics. This study proposes teacher-specific adaptations to the facilitator framework, including an additional category of organisational needs. The findings highlight how citizen science can meaningfully enrich biology education, but only when teachers receive tailored support aligned with the realities of formal schooling.

Learning for sustainability with digital structured inquiry

Marlin Penzenstadler, Melanie Basten, Sebastian Becker-Genschow, Katharina Groß, Kirsten Schlüter, Cristal Schult and Silvia Fränkel

| Poster |

Keywords: *Scientific Inquiry, Sustainability, Digital Learning, Secondary School, Diverse Learning Groups*

Submission #: 134

Quality education enables students to actively shape a sustainable future (UNESCO, 2017). Accordingly, learning environments should foster key competencies such as sustainability (UNESCO, 2017) and scientific inquiry skills (Lederman, 2009) while addressing learner diversity through differentiated support. Since effective strategies for supporting learners in such contexts remain unclear, this study examines whether digital scaffolds, including videos and interactive images, can support structured inquiry on the climate benefits of green facades among secondary students (mean age = 12.77 ± 0.5 years) as effectively as a traditional, individualized approach. Using a quasi-experimental pre–post design with an experimental group (EG; n = 77) and a control group (CG; n = 66), the study addresses the following research question: Does structured inquiry supported by scaffolded digital instructions (EG) produce (a) cognitive and (b) motivational-affective effects comparable to those achieved through personal supervision (CG)? Cognitive and motivational-affective outcomes, including self-efficacy and intrinsic motivation, were measured using self-developed and validated instruments (MSLQ: Pintrich et al., 1991; KIM: Wilde et al., 2009). Repeated-measures ANOVAs showed gains in experimental knowledge ($p < .001$) and positive changes in self-efficacy ($p < .001$) and science career aspirations ($p < .05$), with the CG outperforming the EG in self-efficacy and career aspirations ($p < .05$). One-way ANOVAs showed no group differences in other motivational-affective variables, with both groups displaying positive mean scores. Since students also rated both conditions positively, the findings suggest that digital scaffolding is an alternative to personal supervision during structured inquiry in sustainability education.

The impact of classroom type on student motivation in science and biology education

Mirela Sertić Perić and Mia Fett

| Oral |

Keywords: *Learning Environment, Student Engagement, Educational Settings, Classroom Interaction, Student Motivation*

Submission #: 268

This research investigates how classroom type (specialized vs. universal) influences students' motivation in learning and teaching Science and Biology across primary and secondary schools. An online survey, adapted from the WIHIC questionnaire, was developed to assess six components of student motivation: engagement, cohesiveness, autonomy, task orientation, collaboration, and satisfaction. The study was conducted in seven primary and eight secondary schools in Croatia, with 1025 students participating. Findings indicate that classroom type significantly affects student motivation and satisfaction in both primary and secondary schools. In primary schools, classroom type influenced engagement and certain aspects of cohesiveness, autonomy, collaboration, and satisfaction. In universal classrooms, students indicated higher engagement and autonomy, while specialized classrooms fostered greater collaboration. Satisfaction and cohesiveness among primary school students were similar across both classroom types. In secondary schools, classroom type significantly impacted cohesiveness, collaboration, satisfaction, and certain aspects of autonomy and task orientation. Specialized classrooms in secondary schools promoted stronger cohesiveness, task orientation, and collaboration, while autonomy was higher in universal classrooms. Student responses from primary and secondary schools also revealed significant differences in motivation factors, with primary school students indicating greater overall motivation, particularly in cohesiveness, engagement, task orientation, and satisfaction. Secondary school students exhibited similar levels of autonomy and collaboration, but their motivation in Biology classes was lower overall. This research highlights the importance of classroom design in shaping student motivation and emphasizes the role of the physical learning environment in science education. It can also be concluded that, in the universal classroom compared to the specialized classroom during elementary school Science/Biology lessons, the following components of student motivation are more pronounced: involvement and autonomy. In contrast, in the specialized classroom, student cooperation is greater, while student cohesion and satisfaction are equal in both types of classrooms.

Biodivercity-island hopping – changing attitudes towards plants and insects through action

Lisa Anna Pernausl, Peter Pany, Andrea Möller and Peter Lampert

| Symposia | 6: Pany: Learning to Care: Transforming Biology Education through Biodiversity Awareness

Keywords: *Biodiversity Conservation, Attitudes, Intervention Study, Plant Awareness, Action Competence*

Submission #: 132

The loss of biodiversity is a major environmental issue and a highly relevant topic for biology education. The BiodiverCITY–Island Hopping project aims to foster students' plant awareness and their action competence for insect conservation. Students work together with biologists to create biodiversity islands for plants and insects and engage as citizen scientists. The project builds on an action competence approach that shall support both students' action competence for insect conservation and foster positive attitudes towards insects and plants. This contribution focuses on students' attitudes towards plants and insects, since attitudes are key to shaping willingness to engage in biodiversity conservation. Furthermore, educational settings including an action competence approach are appropriate to foster pro-environmental behavior. Therefore, we have conducted a longitudinal intervention study with approximately 470 Viennese secondary school students over three years (2024-2027) where attitudes towards plants and insects as well as action competence for insect conservation are assessed using a Likert-scale. Results from the first two tests indicate that students showed generally more positive attitudes toward insects after the interventions whereas attitudes toward plants slightly decreased. Additionally, students' self-perceived action competence for insect conservation increased and is significantly correlated to attitudes toward insects. To provide further insights, we are currently interviewing students to explore which specific insects and plants are most present in students' ideas when exploring their attitudes. The results support the refinement of assessment methods and contribute to developing educational strategies that promote long-term engagement with biodiversity conservation. comment (Name of the Symposium): Learning to Care: Transforming Biology Education through Biodiversity Awareness

Main: evolution education in the early years

Patrícia Pessoa, Deborah Kelemen, Isabell Adler, Lucía Vázquez-Ben and Penelope Papadopoulou

| Symposia | 5: Pessoa: EVOLUTION EDUCATION IN THE EARLY YEARS

Keywords: *Evolution Education, Early Science Education, Evolutionary Literacy, Sustainability, Teachers*

Submission #: 249

Understanding evolution is fundamental to scientific literacy. At the same time, fostering evolutionary literacy from the early years is key to developing the scientific reasoning and systems thinking needed to address sustainability challenges. Yet research consistently shows that many students, and even teachers, hold persistent misconceptions about evolutionary processes. These misconceptions, often grounded in intuitive reasoning such as teleological and anthropomorphic thinking, can limit learners' capacity to understand change and adaptation in the living world and its relevance to sustainability problems. This symposium brings together five studies that examine how young learners and their teachers construct, express, and transform their understanding of evolution across different educational contexts. Collectively, these studies explore how evolution education can be meaningfully integrated in the early years to promote conceptual change, scientific reasoning, and informed attitudes toward biodiversity and sustainability. The first paper presents a systematic mapping review of research on evolution education in early childhood, identifying major trends, methodological approaches, and knowledge gaps. It highlights the need for more empirical research on both children's understanding and teachers' preparedness to introduce evolutionary concepts from the earliest stages of education. The second paper explores how third-grade students (aged 7–8 years) use key evolutionary ideas to reason about the past and make predictions about the future, revealing both their intuitive reasoning patterns and their emerging capacity for evolutionary thinking. The third paper investigates the influence of a socioscientific issues-based educational activity, integrating evolution and sustainability, on elementary students' attitudes towards biodiversity conservation and understanding of natural selection, demonstrating how evolutionary literacy can inform pro-biodiversity decision-making. The fourth paper reports on a large-scale classroom intervention comparing two versions of a comprehensive evolution curriculum designed to promote mechanistic understanding of natural selection and speciation, showing significant learning gains without cognitive overload. Finally, the fifth paper examines how experienced primary teachers use teleological and anthropomorphic explanations when teaching science, shedding light on how intuitive reasoning operates as both a cognitive bias and a pedagogical strategy. Together, these studies provide a coherent perspective on how conceptual change in evolution can be fostered from early childhood through primary school and into teacher education and how these impact students' attitudes towards sustainability problems. The symposium aims to stimulate dialogue on how to design

and support developmentally appropriate, conceptually coherent approaches to evolution education that nurture both understanding and agency in addressing sustainability challenges.

Fostering evolutionary literacy and pro-biodiversity attitudes in elementary students through socioscientific issues (symposium: evolution education in early years)

Patrícia Pessoa, J. Bernardino Lopes, Alexandre Pinto and

Xana Sá-Pinto

| Symposia | 5: Pessoa: EVOLUTION EDUCATION IN THE EARLY YEARS

Keywords*: Biodiversity Conservation, Attitudes, Evolutionary Literacy, Socioscientific Issues, Primary Education*

Submission #: 223

The biodiversity crisis demands urgent conservation efforts, yet intraspecific genetic diversity is often overlooked in education. Given its role in species adaptability and ecosystem resilience, fostering positive attitudes towards intraspecific biodiversity conservation is crucial. This study examines the influence of a socioscientific issues (SSI)-based educational activity, incorporating an evolutionary perspective, on elementary students' attitudes and understanding of evolution. The intervention involved 80 Portuguese third-grade students (8–9 years old), using hands-on activities that linked evolutionary concepts to real-world biodiversity challenges. Pre- and post-intervention data were collected through semi-structured interviews assessing students' attitudes and reasoning about intraspecific diversity, and a questionnaire evaluating their level of understanding of evolution by natural selection (LUENS). Results showed a significant increase in students' pro-biodiversity attitudes and LUENS following the intervention. While no students used evolutionary arguments before the intervention, 48% did afterward, with a significant correlation between this reasoning and pro-biodiversity choices. Our results also showed that students with higher LUENS scores more often used evolutionary reasoning in their justifications, and tended to choose the biodiversity seed bag, although this last result was not statistically significant. These findings underscore the importance of integrating evolutionary literacy into primary education to strengthen students' ability to apply evolutionary arguments to sustainability-related decision-making. Future research should explore the replicability of these findings in different contexts and assess the impact of teacher-led implementation on outcomes. It is also important to develop and evaluate strategies to empower elementary school teachers to explore SSI under an evolutionary perspective.

Cultivating plant mentors: a study of pre-service science teachers' appreciation/awareness of plant science education

Charlie Pettit, Rachel Davies and Mark Winterbottom

| Oral |

Keywords: *Plant Education, Plant Awareness, Plant Awareness Disparity, Pre-Service, Teacher Education*

Submission #: 166

Plants are fundamental to ecosystems, climate regulation, and human wellbeing, providing oxygen, primary biomass, essential ecosystem services, and a wide range of cultural and therapeutic benefits. Their biological characteristics position them as key contributors to future solutions for global challenges, including sustainable agriculture, food security, preventing and reversing biodiversity loss, and climate change mitigation. Paradoxically, widespread deficits in plant awareness and engagement persist across society, limiting effective responses to environmental crises and contributing to a declining interest in plant-related disciplines. This issue is recognized within the UK, where national organizations have urged the integration of more engaging and inclusive plant science experiences within school biology curricula to stimulate learner interest and address workforce shortages. Within biology education, research into student and teacher plant awareness has emerged as a growing focus, yet training teachers in this area remains comparatively underexplored. Biology teachers play a critical role in shaping learners' botanical understanding; however, barriers such as limited confidence, lack of pupil interest, and curriculum marginalization continue to impede effective practice. This study investigates the plant awareness of UK pre-service science teachers, examining their perceptions, affordances, and constraints in becoming future 'plant mentors'. Using a mixed-methods approach, this project aims to inform initial teacher education by identifying factors and approaches that support meaningful development of teachers as future 'plant mentors' and stimulate plant engagement in classroom contexts. Findings will contribute to a broader discourse on botanical literacy and its significance within science education, offering pedagogical insights relevant to the ERIDOB community.

Exploring pre-service biology teachers' assessment competence in evolution using a chatbot-supported classroom simulation

Johannes Poser, Daniela Fiedler, Daniel Schönle, Christoph Reich and Ute Harms

| Symposia | 4: Harms: Advancing Evolution Learning – Novel Conceptual and Methodological Approaches to Evolution Education

Keywords: *Assessment Competence, Evolution, Simulations, Chatbots, Teacher Education*

Submission #: 164

Biology teachers' judgment accuracy refers to the agreement between the teachers' judgments and students' actual performance in the biology classroom. It is often used as an indicator of assessment competence, which is an important aspect of biology teachers' professional knowledge. To measure and promote (prospective) biology teachers' judgments in the context of evolution, we developed the SCRBio-evolution, a digital classroom simulation with an embedded chatbot system. In the simulation, participants judge virtual students' explanations of evolutionary principles, threshold concepts, and misconceptions and assign a competence level to the answers. In our online study, we aimed to investigate pre-service teachers' (N = 49) judgment accuracy in the SCRBio-evolution and examine potential predictors (CK, PCK, self-concept, interest) of their judgment accuracy. Using qualitative content analysis, we further explored how participants used the chatbot and to what extent their chatbot requests correspond with their difficulties when using the simulation. As a result, participants judged 1,535 student responses with relatively high accuracy when identifying evolutionary principles, threshold concepts, and misconceptions, but were somewhat less accurate in assigning competence levels. Only content knowledge (CK) significantly predicted teachers' judgment accuracy. Participants' chatbot queries mainly addressed misconceptions, threshold concepts, and principles, reflecting the difficulties they encountered in the simulation. However, participants did not address competence levels in their queries, even though they struggled to identify the correct level, suggesting that they were not fully aware of this difficulty. These findings indicate that support chatbots may not only hold diagnostic potential but also help reveal unrecognized learning difficulties.

Systems thinking in the context of tipping systems – analysing students' concept maps

Greta Sinning Quiroga, Justin Timm and Philipp Schmiemann

| Poster |

Keywords: *Systems Thinking, Tipping Point, Ecology, Concept Mapping*
Submission #: 256

Systems thinking is fundamental to understand global challenges such as climate change and the biodiversity crisis and is frequently examined in biology education. Although tipping is a key property of many systems, it has rarely been studied in systems thinking research. To fill this gap, we investigated students' systems thinking in the context of tipping. We prompted eleven biology students from various study programmes to examine a simulation of two lakes. The simulation offered the opportunity to explore tipping in lakes as a reaction to regulatory measures such as reducing agricultural land use or cutting macrophytes. Participants could observe the effects of these measures on various outcomes like the visibility depth or the phosphate level. We requested the participants to draw concept maps representing the causal relationships within the lake ecosystems. These maps were analysed in a combined structural and semantic approach. The analysis reveals a wide variation in the number of nodes, relations and the nodes' connectedness. Almost all students use agriculture and phosphate as elements in their concept maps. We assume, most of the students identify phosphate as crucial factor for the lakes' states. Nevertheless, no student explicitly mentioned tipping in the concept map. At the conference, we will present a combined analysis of the concept maps with simultaneously collected think-aloud data to provide deeper insights in the understanding of tipping in the context of lake ecosystems.

A sense of wonder towards plant life

Harald Raaijmakers and Dawn Sanders

| Symposia | 6: Pany: Learning to Care: Transforming Biology Education through Biodiversity Awareness

Keywords: *Wonder, Art-Based Science Education, Plant Awareness*

Submission #: 140

Symposium: Learning to Care: Transforming Biology Education through Biodiversity Awareness Goethe's holistic and experiential approach to studying nature (Wingård, 2024) emphasises the affective and value-based connections humans can form with nature, yet such engagement is rapidly fading in industrialised societies (Richardson et al., 2020). Goethe preceded many by expressing the importance of a sense of wonder towards nature in general and towards plants in particular (Goethe, 1786:2009; Carson, 1956:1998; Østergaard & Dahlin, 2008). We believe that his poetic ways of knowing can support teachers and researchers in biology education to develop an aesthetic conception and "understand something genuinely moving about the lives of plants" (Hadzigeorgiou & Schulz, 2014; Sanders, 2022, p. 274). A sense of wonder can foster various reorientations in contemporary personal awareness of the natural world (Zheng et al., 2024) and, therefore, play an important role in biology education. Identifying potential indicators associated with 'a sense of wonder' towards plant life is a useful first step in developing a theoretical framework of how attention to, awareness of, and connections with plants can be afforded in biology education praxis. In this proposal, we position the notion of wonder in relation to established pathways to nature connection (Lumber, 2017). We present 'a sense of wonder' towards plant life as a set of items based on a corpus of conceptual and empirical work. The items aim to map respondents' personal values regarding plant life, divided into five established groups: naturalistic, humanistic, symbolic, moralistic, and aesthetic values (Lumber et al. 2017).

How learning tools shape representation? a comparative study in vr and microscope settings

Ismi Rakhmawati, Lucas Weinberg, Alexander Lichius, Johanna Nagl and Suzanne Kapelari

| Poster |

Keywords: *Virtual Reality, Microscope, Soil Animals, Drawing*
Submission #: 161

In studying small organisms such as soil animals, learners can use various tools, ranging from microscopes to more recent virtual reality. In this research, we explored how these different tools shape high school students' knowledge of soil animals morphology. Participants aged 10-13 were divided into two groups: one group (n=22) used virtual reality and the other group (n=18) used microscopes to observe soil animals. After completing their observations, students were asked to draw what they had observed. The study revealed that drawings from the VR group showed essential features of soil animals, including overall body form, movement, and more cartoonish style. In contrast, microscope group produced more detailed morphological representations, including segmentation, antennae, pedipalps, and accurate number of legs per segment. Drawings from both groups displayed various presentational, orientational, and organizational aspects of the analytical framework, but only the virtual reality group included comparison of soil animals with a coin and woodlouse movement indicated with arrows. Overall, the findings suggest that both tools support learning, but in different ways.

Spaces of efficacy: a mixed-methods study on perceived behavioral control in the context of an environmental education workshop

Finja Rath and Claas Wegner

| Poster |

Keywords: *Environmental Education, Education For Sustainable Development, Self-Efficacy, Perceived Behavioral Control, Mixed-Method*

Submission #: 119

Recent studies show a decline in young people's optimism about the future and their engagement with climate issues. Although education for sustainable development is enshrined in education policy guidelines, school learning settings rarely provide opportunities for young people to experience their own effectiveness. However, this is a key prerequisite for the development of behavioral intentions. The study investigates the impact of an environmental education workshop on students' sustainability-related self-efficacy. It identifies the specific forms of self-efficacy that are activated during the intervention. A mixed-method design combines a quantitative pre-post survey with a qualitative interview analysis. The quantitative results show a statistically significant increase in self-efficacy after the workshop. Qualitatively, the workshop activated self-efficacy in different ways. The participants developed a strong cognitive understanding of sustainability issues and formulated concrete behavioral intentions. The case studies revealed different patterns. Some young people exhibited consistent behavioral changes, while others focused primarily on sharing their knowledge with peers and family. Still others experienced uncertainty despite their high level of reflection because external conditions were unclear. Various barriers cause the gap between their intentions and their actual everyday actions. Added to this are social hurdles and a lack of opportunities for participation. The analysis makes it clear that sustainable behavioral intentions depend less on general self-confidence and more on whether young people find manageable conditions and supportive structures in their everyday lives.

Students' conceptions of scientific evidence and proof in biology and mathematics higher education

Myriam Régent-Kloeckner, Olivier Morin, Véronique Battie,

Faïza Chellougui, Virginie Deloustal-Jorrand and Nicole

Goetgheluck

| Poster |

Keywords: *Scientific Evidence, Proof, Higher Education, Biology, Mathematics*

Submission #: 255

Our personal knowledge is mainly constructed on personal beliefs. These are rarely based on available evidence, but mostly on an intellectual authority. However, the ability to judge the validity of an assumption is a key competence of critical thinking which is promoted by current school programmes as a soft skill. As in everyday speech, 'proof' and 'evidence' are used interchangeably but in science they refer to slightly different concepts. Mathematics and biology do not use 'proof' and 'evidence' in the same ways that may represent different styles of reasoning. Furthermore, how evidence or proof is processed depends on the normative rules of each scientific community. Our aim is to develop a theoretical framework, that can be used in both mathematics and biology education contexts to study students' conceptions of scientific evidence and proof. In this poster presentation, we will present the resulting theoretical framework obtained from a epistemological work in our two disciplines.

Investigating self-related constructs in girls-only groups with biology and informatics content

Julia Rehkemper and Claas Wegner

| Poster |

Keywords: *Gender, Self-Efficacy, Self-Concept, Out-Of-School Learning, Single-Sex Programs*

Submission #: 195

To attract women to scientific professions and STEM fields, single-sex programs for girls have been established. However, the suitability of these programs for encouraging girls is often not thoroughly examined (blinded). This research project (blinded) investigates the impact of same-sex learning on girls' self-related characteristics while participating in an extracurricular program that combines biology and IT content. The study involves a same-sex experimental group of female seventh-graders and a mixed-sex control group, both participating in the extracurricular course over two semesters. At the beginning and end of each semester, participants complete a quantitative survey (t0-t3) that gathers information on their scientific self-concept and self-efficacy in working with technical systems. The development of these constructs was analyzed using the Wilcoxon signed-rank test between the initial time point (t0) and the assessments at t1 and t3. Additionally, course-specific self-efficacy was evaluated through guided interviews. The quantitative data indicated that there were no significant changes in scientific self-concept or self-efficacy in dealing with technical systems from the initial assessment (t0) to the subsequent evaluations at t1 and t3, although the sample sizes were quite small. Analysis of the interviews revealed slight differences in the affective states of the experimental and control groups. At this stage, the implementation of single-sex courses aimed at encouraging girls in biology and informatics cannot be recommended or discouraged. A comprehensive discussion of the results will be presented in the upcoming presentation.

School vaccine education needs to take account of cultural issues

Michael Reiss

| Symposia | 2: Dillon: Culturally Responsive Biology Education

Keywords: *Culturally Responsive Pedagogy, Vaccination, Vaccine Education, Respect For Students*

Submission #: 185

Science education has quite slow to adopt ideas from culturally responsive pedagogy, perhaps because of the widespread presumption that science is objective and therefore its 'truths' exist independent of the student. However, biology education has been more responsive than other branches of science education, for example, in the case of evolution education. Here, I argue that there is much that can school vaccine education can learn from culturally responsive pedagogy. Vaccination is one of the most cost-effective ways of avoiding disease: it currently prevents 2-3 million deaths a year, and a further 1.5 million could be avoided if global coverage of vaccinations improved. Yet vaccine rejection is rising, and was rising before the advent of COVID. School biology education often gives the impression that it is obvious that vaccination is a good thing and that those who refuse vaccinations for themselves or their dependents are either stupid or selfish. Yet a more careful consideration as to why certain groups are more likely to reject vaccination tells a different story. In my presentation I will consider four examples where cultural factors help explain vaccine rejection: polio vaccination in Pakistan; the human papillomavirus (HPV) vaccine in some countries, vaccines against COVID; and vaccines funded by the Bill & Melinda Gates Foundation. I conclude that when teaching about vaccination, we need pedagogies that respect and understand students.

Investigating biodiversity challenges using an educational design research approach

Maxi Ritter and Armin Lude

| Poster |

Keywords: *Biodiversity Loss, Challenges, Educational Design Research, Nature Experience, Sustainability*

Submission #: 172

The project applies the Educational Design Research framework to examine how the use of “Challenges” can foster biodiversity-friendly behavior. In light of the global loss of biodiversity and the gap between environmental awareness and actual behavior, proposing everyday challenges can serve as an innovative approach to encourage meaningful action. These “Challenges” involve both activities that support biodiversity (e.g., creating a flower meadow) and actions that reduce harmful practices (e.g., reducing food waste). The study investigates the conditions under which such challenges are effective and identifies factors that facilitate or hinder participation. The challenges are implemented in the mobile app H.O.P.E., through which participants receive information, track their activities, and are motivated through gamification elements. Two surveys and interviews were conducted with adults, school classes, and youth groups to explore supporting and limiting factors. Preliminary results indicate that 49% of respondents would use such an app, particularly if it includes virtual rewards, educational content, and opportunities for social interaction. The main barriers to participation are lack of time and interest. Participants considered reducing food waste and litter especially feasible, while activities such as planting native species, collecting waste in nature, and providing habitats or food sources for animals were perceived as most effective for biodiversity. The findings emphasize the need to address information and knowledge gaps regarding biodiversity conservation. Offering clear information, practical tasks, and opportunities for social engagement may enhance participation. Further analyses aim to provide specific recommendations for designing more effective challenges and improving app-based engagement with biodiversity.

Where can we foster stem career aspirations? empirically comparing an in-school and out-of-school learning place

Max Romanik and Claas Wegner

| Poster |

Keywords*: Out-Of-School, Career Guidance, Stem, Artificial Intelligence*

Submission #: 114

Although out-of-school learning places are associated with the expectation of promoting STEM careers, there is a research gap in this area. This study attempts to contribute to the understanding of the suitability of out-of-school STEM learning places for promoting STEM career aspirations and compares an out-of-school student laboratory at a university with an in-school learning place. An intervention was designed for this purpose, with the specific aim of reducing STEM stereotypes. STEM stereotypes, career-related STEM self-efficacy, career-related STEM outcome expectations, STEM interest and STEM career aspirations were surveyed before and after the intervention. A mixed ANOVA for n = 89 students at the out-of-school learning place and n = 47 students at the in-school learning place showed significant time effects for STEM career aspirations ($p = .006$) and career-related STEM self-efficacy ($p = .001$) in the total sample. Only for STEM interest a significant interaction effect was found ($p < .001$), with Bonferroni-corrected post-hoc tests showing a significant increase at the out-of-school learning place ($p = .010$). This indicates that the intervention was effective in improving the students' STEM career aspirations and self-efficacy. A more positive change in STEM interests could be found at the out-of-school learning place. This suggests that at least student labs as out-of-school learning places can foster a more positive dynamic for increasing STEM career aspiration than schools, although the composition of the sample and the lack of follow-up tests should be viewed critically.

Developing capabilities for critical examination of biology-related issues in the media. a design-based study in upper secondary school

Carl-Johan Rundgren, Maria Andrée, Cecilia Dudas, Kristin Persson and Josefin Reimark

| Oral |

Keywords: *Nos, Critical Examination, Science In Media, Upper Secondary School*
Submission #: 17

Science education aims to educate students for participation in democratic society and to become scientifically literate citizens. The curriculum emphasizes the importance of providing students with capabilities for critically evaluating science and processes of scientific knowledge production in the media. This study focuses on how teaching about Nature of Science (NOS) can support student participation in critical examination of biology-related topics in the media. A challenge for teachers is how to address critical examination, not accepting all views as equally valid, while at the same time, making examination of scientific processes personally relevant to students. This study aims to develop didactic design principles for designing teaching aimed at supporting students' capabilities for critical examination of science issues in the media. The project is design-based with interventions in 3 cycles in two Swedish upper secondary schools. The data collection includes 4 types of data: research lessons, collection of artifacts and pre- and post-questionnaires. The data is analyzed using qualitative content analysis. The results show that the NOS-related concepts such as peer review, tentativeness, consensus and method/data were of special importance for students' capabilities for critical examination. In cycle 3, we saw increased qualifications, but challenges regarding some of the NOS-related concepts remained.

Exploring primary pupils' understanding of the immune system using drawing tasks and semi-structured interviews

Eliza Rybska and Wiktoria Michalak

| Oral |

Keywords: *Students' Understanding, Conceptions, Immune System, Visual Representations, Multimodal Learning*

Submission #: 54

Understanding the human immune system poses significant conceptual challenges for learners due to its abstract, complex and dynamic nature. Students often develop fragmented conceptions that combine scientific ideas with everyday experiences and media representations. Exploring these early conceptions provides valuable insight into how young learners construct biological understanding before formal instruction. This study investigated how fourth-grade pupils conceptualise the functioning of the human immune system, despite the topic not yet being included in their curriculum. Forty pupils participated in an exploratory study in which they were asked to "show what happens in the body when harmful factors penetrate it." Each pupil produced a drawing, a short written description and took part in an individual semi-structured interview. Data were analysed thematically, focusing on visual and verbal representations. Pupils demonstrated intuitive, emotionally charged and partly scientific understandings of immunity. Their conceptions drew on scientific knowledge, personal experiences and media messages. Visual and verbal representations complemented each other, confirming the diagnostic value of multimodal approaches. Anthropomorphic depictions supported the interpretation of invisible biological processes and reflected developmental reasoning rather than misconceptions. This study is unique because it combines drawings and verbal explanations to explore how children understand the immune system, revealing the influence of personal knowledge, media exposure and contemporary events such as the COVID-19 pandemic. The findings highlight how children's early ideas about immunity are socially and culturally embedded. Supporting such multimodal expression in teaching may help bridge intuitive and scientific perspectives.

Plants in action against climate change

Renata Ryplova, Tomas Mrhalek, Zbynek Vacha and Tereza Brcakova

| Oral |

Keywords: *Plant Awareness, Environmental Locus Of Control, Eco-Anxiety, Climate Change Education*

Submission #: 262

Climate education seeks not only to improve students' understanding of climate change but also to strengthen their capacity for meaningful action. An important factor shaping such engagement is the environmental locus of control (ELoC), which reflects whether individuals view environmental outcomes as dependent on their own behaviour (internal ELoC) or on external forces (external ELoC). Supporting an internal ELoC may also help reduce eco-anxiety, a growing form of distress among young people. One promising approach is to deepen students' understanding of plant-related processes in climate change mitigation, as plant awareness remains low despite the crucial ecological functions of vegetation. This study aimed to adapt and/or develop research tools for measuring eco-anxiety and plant-related ELoC in the Czech context and to establish baseline levels before implementing new educational interventions on plant role in climate change mitigation. Two existing instruments, the Hogg Climate Anxiety Scale and the Climate Change Worry Scale (CCWS), were translated and psychometrically evaluated. A new 20-item ELoC questionnaire focused specifically on the role of plants in climate mitigation was also developed and validated. All instruments were tested with 239 Czech students aged 11–19. The Hogg scale showed insufficient reliability, whereas the CCWS demonstrated strong psychometric quality. The new ELoC instrument related to plants exhibited good internal consistency and a meaningful factor structure encompassing internal and several external dimensions of environmental control. Findings indicate that students consider knowledge about plant-related climate functions central to their sense of environmental agency. The validated tools will support the development of teaching activities aimed at enhancing plant awareness, strengthening internal ELoC, and reducing eco-anxiety.

Draw-and-explain to learn: collaborative processes to learn about the immune system

Karen Rysgård and Helena Bichao

| Oral |

Keywords: *Drawing-Based Instruction, Immunology, Active Learning, Collaborative Learning, Upper Secondary Education*

Submission #: 269

The immune system is highly complex, making its learning challenging (Sharon et al., 2020; Siani et al., 2024), and active learning strategies are recommended. Drawing- to-learn has increasingly gained recognition in science education, not only has a means of visualizing knowledge, but also as promoting active knowledge construction, reflection and metacognition (Ainsworth & Scheiter, 2021; Tytler et.al. 2013; Wu & Rau, 2019). This study examines how a drawing-based learning sequence, structured around the Plan–Draw–Evaluate (PDE) model (Park et al., 2021), can support upper secondary students' understanding of the immune response to bacterial infection. Grounded in constructivist and sociocultural learning theories (Ainsworth & Scheiter, 2021; Vygotsky, 1978), the design emphasizes active engagement, collaboration, and iterative thinking. The roles of drawing and presentation are examined both individually and in relation to each other to explore the how collaborative learning process involving drawing and explanation, work for constructing knowledge of the immune response to bacterial infection. We investigate 1) which strategies learners use in a collaborative learning process with drawing and, 2) what affordances learners attribute to the drawing and the presentation activities Adopting a qualitative methodology, data were collected through group interviews, classroom observations, and student drawings. Reflexive thematic analysis (Braun & Clarke, 2022) with an inductive approach was used to identify patterns in students' experiences. Three themes emerged: (1) Drawing for insight, where planning and creating drawings acted as a catalyst for learning and metacognitive reflection; (2) Learning through encountering others' understandings, highlighting the role of collaboration and peer interaction in clarifying concepts; and (3) Explain, repeat, and understand, showing how oral explanations during gallery walks consolidated knowledge and confidence, despite limited questioning between groups. Findings indicate that well-designed drawing activities foster disciplinary engagement, agency, and metacognitive awareness. The drawing task introduced an information gap that encouraged autonomy and active knowledge construction, while collaboration provided a safe space for informal reasoning. The gallery walks shifted learning toward more formal disciplinary reasoning, reinforcing understanding through explanation and repetition. The study thus contributes to clarifying how teachers can facilitate drawing-based instruction in immunology, and to a growing body of research showing that working with representation (drawing) in activities that provide autonomy, elicits experiences of mastery and agency. This study contributes to research on innovative approaches for teaching complex scientific content by

demonstrating the potential of drawing and collaborative explanation as tools for active, reflective, and socially mediated learning in immunology.

Evaluating a teacher training module on energy and sustainable development: a mixed-methods study of competence development in education for sustainable development

Rolf Saarna and Anne Laius

| Poster |

Keywords: *Education For Sustainable Development, Teacher Training, Circular Economy, Sustainable Food Systems, Systems Thinking*

Submission #: 34

This study evaluates the design, implementation, and outcomes of a professional development module aimed at enhancing teachers' competencies in Education for Sustainable Development (ESD), with a focus on energy, sustainable food systems, and the circular economy. The module sought to strengthen systems thinking, digital competence, and participatory pedagogy to enable educators to integrate sustainability across subjects and learning contexts. Using a mixed-methods approach, data were collected from 25 participants through post-training questionnaires combining Likert-scale and open-ended items. Quantitative results showed consistently high achievement across module objectives (mean scores above 5.0 on a 6-point scale), with teachers reporting significant gains in understanding the role of energy in sustainable development and readiness to apply ESD principles in teaching. Qualitative feedback revealed that participants particularly valued practical methods, vignette-based learning, real-life examples, and collaborative exercises, which enhanced engagement and professional confidence. Most participants intended to transfer the acquired knowledge into classroom practice through subject integration, cross-curricular projects, and adapted lessons for younger learners. Overall satisfaction was extremely high (mean = 5.88), with strong interest in follow-up training. Suggestions for improvement focused mainly on course duration and scheduling rather than content. The study concludes that the module effectively strengthened teachers' sustainability competencies and demonstrated the value of participatory, systemic, and practice-oriented approaches in teacher education. Future iterations should expand digital integration and extend training duration to support sustained professional learning communities.

Cultivating climate activist teachers: insights from a course on environmental education and action- a case study

Dana Sachyani and Adiv Gal

| Oral |

Keywords: *Climate Change Education, Teacher Agency, In-Service Teachers, Sustainability, Activism*

Submission #: 8

This study examines how higher education can help teachers develop agency in addressing climate change, combining scientific knowledge with action-oriented pedagogy. The research focused on a semester-long course for in-service science teachers in Israel, all of whom were in their fourth year of studies and internship (induction). The course was designed to integrate climate science with experiential learning and activism. Unlike traditional courses that emphasize conceptual understanding, this one combined scientific content, field experiences, and collaborative projects aimed at encouraging environmental responsibility. The study used a qualitative approach, drawing on reflective journals, final projects, and open-ended questionnaires. Analysis followed an inductive thematic process, identifying central aspects of the teachers' learning and professional growth. The findings highlight five main themes. First, experiential learning created emotional engagement that deepened understanding of climate science. Second, relevance to daily life increased motivation to integrate sustainability into practice. Third, collegiality and co-learning built a supportive community that encouraged action. Fourth, teachers identified a gap between personal vision and systemic constraints, as they struggled to balance activism with curricular demands. Finally, reflective processes helped teachers reframe their professional identity and view themselves as agents of change. The study concludes that higher education courses on climate change can go beyond knowledge transmission and empower teachers as reflective practitioners and activists. By combining scientific content, experiential methods, and opportunities for action, such programs can prepare educators to guide future generations in responding to the climate crisis.

Why teacher professional learning programs can fail: evidence from a professional learning program on scientific reasoning for biology teachers

Richard Sannert, Verena Petermann, Janet Carlson, Jan van Driel and Moritz Krell

| Oral |

Keywords: *Professional Learning, In-Service Biology Teachers, Scientific Reasoning, Explicit Instruction*

Submission #: 208

Professional Learning (PL) programs are an essential means for supporting biology teachers in their teaching and, ultimately, enabling students to acquire 21st century skills, such as scientific reasoning (SR). Yet, even well-designed PL programs do not always show positive effects on all teachers, classroom practice and students. For this reason, it is argued that individual barriers and amplifiers can influence progression: (1) acceptance filter — factors influencing teachers' uptake of PL content; (2) implementation filter — factors influencing the implementation of PL content in classrooms; and (3) student impact barriers — factors influencing the development of students' SR competencies. This qualitative case study investigates three contrasting cases of biology teachers who participated in the same PL program on SR but showed different trajectories during and after the program with regard to their classroom practice to promote SR. Interviews revealed both general and specific barriers and amplifiers to promoting SR, such as difficulties in assessing SR competencies or lack of time to adapt inquiry lessons. The barriers and amplifiers each teacher reported varied considerably, suggesting that individualized support may be more effective than a "one-size-fits-all" approach in PL programs. Our findings can inform PL facilitators in helping teachers identify their individual barriers and develop tailored strategies to overcome them.

Supporting coping strategies through emotion-sensitive climate change education

Wanda Sass and Jelle Boeve-de Pauw

| Oral |

Keywords: *Climate Change Education, Climate Change Emotions, Coping Strategies, Emotion-Sensitive Climate Change Education (Cce)*

Submission #: 75

The more society fails to address climate change issues, the higher the occurrence of uncomfortable emotions such as anxiety and worry. Different coping strategies have been distinguished, as are their associations with pro-environmental action. Emotion-focused coping avoids thinking about climate change (CC), meaning-focused coping trusts others, and a problem-focused coping strategy discusses (possible solutions to) CC with others. While the former was found to be negatively associated with pro-environmental action, the latter two seem to enhance such behaviour. The question remains how science and biology education can foster coping strategies (i.e. meaning- and problem-focused coping strategies) that enhance pro-climate action. The study we present here aims to explore this question through a quantitative pilot study. We adapted and validated survey instruments to tap into coping strategies and added a novel emotion-sensitive CCE scale. Results of correlation analysis showed a positive association between emotion-sensitive CCE and meaning- and problem-focused coping; a negative association with an emotion-coping strategy. This confirms the importance of emotion-sensitive educational approaches as found in earlier research. The tentative results presented at this stage, stem from a Dutch and Flemish convenience sample for a pilot study in which the measurement instruments were validated. We look forward to discussing more generalisable findings from the main study in the Netherlands, Austria, and Czechia for which data collection through purposive sampling is ongoing at the time of submission. Both studies are conducted in the context of the HARP project (Hope and Resilience Perspectives in CCE), funded by the European Union.

Exploring affective engagement between london's learners and the more-than-human

Rachel Sawle and Neil Hart-Camus

| Poster |

Keywords: *More-Than-Human, Affective Engagement, Urban Diasporic Learners, Sociocultural Learning, Post-Colonial Nature*

Submission #: 245

Biology learning across all phases in English schooling has a narrow focus on knowledge acquisition through exam focused teaching and an anthropocentrically biased curriculum (Dempster, 2025; Glackin & King, 2020). Existing research shows disinterest with the more-than-human among biology learners. London's multicultural classrooms are populated by diasporic learners with diverse world-views and knowledge systems relating to the more-than-human. These remain underexplored as a learning medium in London's classrooms. The power of affective engagement in London's classrooms, in an urban ecology where diasporic learners and more-than-human entities share entangled socio-cultural histories and presents, remains under researched. Using Vygotsky's sociocultural learning theory and aspects of Bioecological Systems Theory (Bronfenbrenner, 2004, Vygotsky & Cole, 1978), we explore how young people develop more-than-human relationships mediated by sociocultural contexts, and conceptualise these relationships, from immediate, personal encounters to the broader social, cultural and chronological contexts that shape them. The research draws on Barua's (2022) categorisation of post-colonial nature to investigate the impact of shared histories of displacement, migration and colonial legacies shape human and more-than-human relations. The presentation is based on existing research across younger and older learners in London, investigating affective engagement with diasporic learners and the more-than-human in urban place. This study investigates how urban diasporic learners relate to the more-than-human world, how pedagogical approaches can capture forms of affective engagement shaped by diverse sociocultural backgrounds, and how these relationships shift over time under the combined influences of schooling and sociocultural contexts. It also examines how affective engagement can inform pedagogical approaches to deepen learning in biology classrooms. Researchers used approaches specific to the age of learners. Primary learners participated in focus groups using photo-prompts and concept cartoons to explore relationships to the more-than-human. Older learners engaged in photo-walks (Pyyry, 2016) to support attentive engagement with urban more-than-humans, followed by semi-structured interview and narrative enquiry where participants shared the story of their photos and their experience of engaging with the more-than-human. While data is yet to be fully analysed early analysis suggests feelings of empathy and kinship with plants in younger learners. In older learners, work suggests that storytelling through photo-walks supports learners to focus on the shared politics and lived-experiences with city's post-colonial nature and to consider the urban more-than-human differently through engagement with shared sociocultural histories and presents. The poster will present these

findings along with a working model for exploring affective engagement with the more-than-human in diasporic urban biology learners.

Exploring the qualities of nature experiences across urban and rural learning environments

Pascal Schaldach, Matthias Wilde and Tim Kirchhoff

| Poster |

Keywords: *Nature Experiences, Field-Based Learning, Qualitative Study, Qualities Of Nature Experiences*

Submission #: 112

Outdoor and field-based learning offer authentic contexts for connecting biological concepts with personal experiences, thereby fostering curiosity, motivation and ecological understanding. However, the specific qualities that make nature experiences meaningful are not well understood. This study will examine how visitors experience and interpret nature in environments that vary in their degree of naturalness, accessibility and purpose. Semi-structured interviews will be conducted with visitors in different settings, transcribed verbatim and analysed using qualitative content analysis. The study aims to identify recurring patterns of meaning, emotion and knowledge construction that constitute the qualities of nature experiences. By revealing how different environments offer distinct ways of engaging with nature, the study will contribute to a deeper theoretical and empirical understanding of outdoor learning. Ultimately, these insights will inform the design of meaningful, evidence-based opportunities for practice-oriented teaching and learning as well as support the development of a conceptual framework for learning environments.

Cultivating interest in sustainable nutrition: exploring what makes nutrition education work

Jana Schilbert and Annette Scheersoi

| Poster |

Keywords: *Interest, Nutrition, Sustainability Education, Project-Based Learning*
Submission #: 222

Cultivating interest in sustainable nutrition is crucial to addressing urgent global challenges such as climate change, biodiversity loss, and food insecurity stemming from unsustainable agricultural practices and limited consumer acceptance of alternative diets. The central rationale of this research is rooted in the need for adaptive measures in food production and consumption to safeguard both human and planetary health for future generations. However, meaningful engagement with sustainable nutrition, especially among youth, is hindered by knowledge gaps, limited opportunities to experience novel foods, and persistent prejudices or concerns regarding non-traditional alternatives. This project investigates educational interventions – specifically, workshops with hands-on formats – designed to foster interest in sustainable food production and alternatives. Drawing on the Person-Object Theory of Interest (POI), the study defines interest as the relationship between individuals and sustainability-oriented nutrition themes. The primary objective is to elucidate which conditions and methods enhance students' interest in these themes. The research utilizes a qualitative, triangulated design employing semi-structured interviews with diverse stakeholders (i.e. pupils, teachers, teaching degree students, and scientists) to investigate which workshop conditions foster students' interest. The interviews were analyzed inductively using MaxQDA software. Findings indicate that a supportive, inclusive team culture, flexible planning, and communicative structures underpin effective workshop implementation. Methodological diversity during the workshops combining practical cooking experiences, excursions, and media production proves effective for sustaining pupils' interest, while interactions with external experts enhance the authenticity and relevance of their learning. The research concludes that the success of sustainable nutrition education depends on organizational support and clear communication structures that facilitate flexible and inclusive workshop planning. Equally important are varied, hands-on learning experiences during the workshops, which foster student's interest in sustainable nutrition – and might ultimately support the development of responsible consumption behaviors.

Professional development for inquiry-based learning: what content matters to pre-service and in-service biology teachers?

Till Schmäing, Leo Siiman, Natalie Baumgartner Hirscher, Marlene Ganz, Moritz Krell, Holger Meeh, Sergios Nicolaou, Marios Papaevripidou, Yvoni Pavlou, Iris Schiffl, Martina Schuknecht, Simone Suppert, Tanja Thumann, Armin Baur and Andreas Lampis

| Oral |

Keywords: *Inquiry-Based Learning, Professional Development, Teacher Education*
Submission #: 39

Inquiry-Based Learning is recognized as an effective approach in biology education and plays an important role in fostering scientific literacy. To ensure high-quality teaching, teachers require targeted professional development (PD) aligned with their specific needs and educational contexts. This study explores the preferences of pre-service and in-service biology teachers regarding IBL-related content across three different education systems: Austria/Germany, Cyprus and Estonia. Data were collected via an online questionnaire, combining closed and open-ended questions. Participants (n=200) rated the relevance of four IBL-related content areas for PD — IBL in general, experimentation, assessment, and differentiation — regarding advantages, challenges, and examples. Descriptive statistics, t-tests, and ANOVAs were used to analyze differences between pre-service and in-service biology teachers as well national education systems. Findings indicate high overall agreement on the importance of including examples and addressing both benefits and challenges in all content areas. While pre-service and in-service teachers agreed on most aspects, significant differences emerged in the need for examples related to general IBL and experimentation, with in-service teachers expressing stronger preferences. Furthermore, substantial cross-national differences were found, particularly between German/Austrian and Estonian respondents. The results indicate the need for coherent teacher education across career phases. These insights can inform the design of more effective, context-sensitive PD programs that better support teachers in implementing IBL.

Exploring students' conceptions of wild bees – insights from a qualitative study using concept maps

Theresa Schmidt, Alexander Georg Büssing and Dagmar Hilfert-Rüppell

| Oral |

Keywords: *Student Conceptions, Biodiversity, Concept Mapping, Sustainability, Wild Bees*
Submission #: 202

Among the global decrease in insect diversity in recent decades, wild bees in particular have experienced a severe decline. As wild bees are essential pollinators of both cultivated and wild plants, their decline has significant ecological and economic implications. While protective measures are of great significance, there is a lack of awareness regarding the diversity of bees and its importance. To address this issue in biology education, students' conceptions must be considered, as they form an important basis for learning processes and should be taken into account to foster scientifically accurate concepts. This qualitative study explored the conceptions of 28 secondary school students (f = 15, m = 13, M age = 11.2 years, SD = 1.6) in Germany regarding wild bees during a summer camp. The students created digital concept maps on iPads depicting wild bee characteristics. The results were analyzed using qualitative content analysis based on an inductively developed coding guide. The analysis revealed considerable differences in students' conceptions of wild bees. A notable finding was the attribution of honey bee traits, such as their highly eusocial lifestyle, to wild bees. While most students acknowledged that wild bees are threatened, their awareness of conservation measures was limited and restricted to nesting opportunities. Core scientific concepts, such as the predominantly solitary lifestyle, were rarely represented. These results underscore the importance of targeted educational interventions that strengthen students' awareness of bee diversity and conservation issues. Further quantitative research using broader samples is needed to strengthen the generalizability of the results.

Bridging the dimensional gap: comparing 2d and simplified 3d models for teaching translation - a design-based research project

Mario Schmiedebach and Claas Wegner

| Poster |

Keywords: *3D-Printed Models, Molecular Biology Education, Design-Based Research, Haptic Learning, Biological Models*

Submission #: 111

Understanding molecular processes such as translation is challenging for students because these processes occur in dynamic three-dimensional environments but are usually represented through static two-dimensional diagrams. While research suggests that 3D models can support spatial reasoning and engagement, it remains unclear whether simplified, low-detail 3D-printed models provide sufficient pedagogical benefits compared with traditional 2D paper-based representations. This Design-Based Research (DBR) project investigates whether modest increases in tangibility improve students' learning experiences and competencies in molecular biology. Grounded in cognitive load theory and constructivist learning principles, the project develops and iteratively refines 2D paper-based materials and simplified 3D-printed models of the translation process. The first evaluation cycle involved 30 German secondary students (grades 12–13) assigned to either the 2D (n = 11) or 3D (n = 19) group. Students completed a validated questionnaire assessing frustration, motivation, engagement, process-related competencies, self-efficacy, and self-concept. A second, ongoing cycle with 93 students uses a pre–post design to assess knowledge gains and affective factors. Findings from the first cycle show clear advantages of simplified 3D models. Students in the 3D group reported significantly lower frustration and higher active and social engagement (medium to large effect sizes), as well as stronger perceived gains in knowledge construction competencies. These results suggest that even low-complexity tactile models can support embodied reasoning and reduce cognitive load. No significant differences emerged for interest, intrinsic motivation, self-efficacy, or self-concept, which may require longer interventions. Overall, the findings indicate that simplified 3D models offer meaningful pedagogical benefits for teaching translation. The second cycle will further examine objective learning outcomes, contributing both practical recommendations and theoretical insights into how haptic affordance influences learning in molecular biology.

Climate emotions in place-based education: linking agency, hope, interest and worry through person-situation interaction theory

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| Oral |

Keywords: *Climate Emotions, Climate Change, Agency, Hope, Worry, Interest, Place-Based Education, Person–Situation Interaction Theory, Environmental Education*

Submission #: 188

Climate Change Education (CCE) seeks to foster not only scientific understanding but also emotional and motivational engagement that supports climate action. This study examines four key climate-related emotions — worry, hope, interest, and agency — as central mechanisms of engagement. It combines the Person-Situation Interaction perspective, which explains emotions as products of dynamic exchanges between stable personality traits and situational contexts, with the TESSERA model. This model describes how repeated state experiences can shape long-term dispositions. A place-based "Climate Rally" intervention provides an authentic, gamified learning environment that connects local climate issues to concrete actions. The preregistered quantitative design links trait-level assessments with repeated state measures collected during the intervention. Participants were students in grades five to nine (N = 130; target N ≈ 700) visiting a place-based, gamified 2.5-hour CCE-rally. Trait data on climate emotions and personality were gathered one week before participation. During the intervention, students completed short questionnaires after each rally step, capturing state emotions and situational perceptions. Preliminary analyses revealed three emotional-motivational profiles: engaged (high hope, agency, and interest), disengaged (low emotional involvement), and one in between. All climate emotions correlated positively, and openness and agreeableness were linked to stronger hope and agency. Mean state emotions differed significantly across profiles, with engaged students showing higher situational hope, agency, and interest. These results demonstrate that emotional engagement in CCE arises from the interplay between personality and situational experience, highlighting the importance of emotionally resonant, adaptive learning environments that build agency, hope, and resilience.

Situational perception and performance: use of prompts in data-based decision-making tasks

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| Poster |

Keywords: *Data Literacy, Data-Based Decision-Making, Prompts, Personality Characteristics, Situational Perception*

Submission #: 183

Biology education offers authentic contexts in which learners can use complex data for informed decision-making. This requires engaging in data handling activities such as gathering, processing and visualizing data. These activities align with problem-solving strategies, revealing that applying them is challenging for learners. Prompts can help address these challenges by fostering information processing and metacognitive reflection. However, learners differ in how effectively they use prompts, and these differences may be linked to personality characteristics (traits and states) and situational perception. This study examines how traits (e.g., Big Five, Need for Cognition), states (e.g., cognitive load, interest, motivation) and situational perception are related to learners' use of prompts and their performance outcomes. This study is grounded in a mixed methods design combining trait and state characteristic assessments as well as the measurement of situational perception during a data-based decision-making task. Learners complete data handling activities supported by cognitive and metacognitive prompts. Personality traits are assessed through a pre-task questionnaire, while state characteristics and situational perceptions are repeatedly captured in situ using experience sampling. Prompt use is analyzed through eye-tracking data, navigation paths and qualitative analysis of written responses. The findings are expected to deepen our understanding of how personality characteristics, situational perceptions and the use of prompts relate to one another. Insights from this study aim to inform the development of adaptive guidance that tailors prompts to learners' personality characteristics, thereby supporting more effective use of prompts and, subsequently, data handling in authentic biological contexts.

From rules to discovery: sensory experience and relation to more-than-humans in scientific mediation at the botanical garden

Alain Sénécail, Laure Kloetzer and Julien Leuenberger

| Oral |

Keywords: *Sensory Experience, More-Than-Humans, Scientific Mediation, Environmental Education, Multimodality*

Submission #: 184

This paper investigates how the multimodal discourse of mediation contributes to shaping young children's sensory and cognitive encounter with living beings during a botanical garden activity. Drawing on a micro-analysis of an educational session with six-year-old pupils, the study examines how verbal and embodied actions are coordinated to guide attention, structure sensory exploration and support early conceptualisation of the living. The results show that the educator's gestures, postures and formulations establish a specific interpretive framework that orients how children perceive and engage with plants and other organisms. By mobilising the garden environment as a resource, the educator links children's immediate sensory experiences with the construction of biological categories, for example by moving from photographs to the observation of actual plants or by integrating environmental contingencies such as animal presence. Multimodal cues also play a role in transforming intuitive or animistic reasoning into more elaborated criteria for identifying living beings. Overall, the analysis demonstrates that scientific mediation does not solely rely on verbal explanation but on the coordinated use of embodied, spatial and material resources that make the living world perceptible and intelligible for young learners.

Bringing plankton research into the classroom: an essential step toward a climate literate society

Adva Shemi, Gilat Brill and Anat Yarden

| Poster |

Keywords: *Biological Literacy, Marine Biology, Climate Change, Teacher Professional Development, Mechanistic Reasoning, Researcher–Practitioner Partnership, Plankton Biology*

Submission #: 36

A drop of seawater contains millions of microscopic plankton which act as drivers of marine biogeochemical cycles, modulate seawater and atmospheric composition and shape the global climate. These powerful plankton are also threatened by seawater pollution, warming and acidification. Thus, exploring plankton biology is essential to understand climate change mechanisms and global impact. Yet, this is not reflected in teaching programs, maintaining knowledge gaps regarding plankton and climate change among the next generation. Plankton biology is a relatively young science and therefore adequate educational programs are not widely available. In this ongoing project, we create a partnership between educators and scientists to construct a novel plankton-inclusive curriculum which defines key knowledge components and practices needed to improve students' understanding of our changing world. To promote teachers' proficiency to teach plankton biology in the context of climate change, we design training programs and a website, offering a digital textbook, class activities, presentations and experiments adapted for educational levels. The impact of the teachers' professional development on their ocean literacy and perspectives about plankton and climate change is being assessed during the project. Learning about plankton is critical to understanding how we negatively impact planet Earth, and also how we can heal it by applying plankton-based solutions to environmental problems. We wish to inspire international plankton-inclusive education, to advance climate literacy among the next generation and to foster an optimistic viewpoint as an effective strategy to mitigate and adapt to the climate crisis in the long term.

Mechanistic reasoning as a lens on children's plant awareness

Yael Shtechman and Michal Haskel-Ittah

| Oral |

Keywords: *Mechanistic Reasoning, Plant Awareness, Elementary School Students, Visual Ranking Tasks*

Submission #: 50

Plant awareness disparity refers to the common tendency to overlook and undervalue plants, often referred to as "plant blindness," and is primarily driven by limited exposure to plants in urban environments rather than inherent factors. Recent methods, including validated survey tools, art-based representations, and visual tasks, have established plant awareness. Mechanistic reasoning, the ability to identify components, their properties, and interactions to explain a phenomenon, may play a key role in shaping children's plant awareness and can be explored through carefully designed tasks and interviews. This study explores what role does elementary students' knowledge plays in their prioritization of the importance of plants and the reasoning behind their choices. Twenty-three third-grade students at an educational farm ranked nine images (trees, animals, plants, humans) by importance to daily life and the environment, then explained their ranking. Follow-up interviews focused on students who referred to plant mechanisms in their explanations. Most children ranked trees highly, noting their role in producing oxygen, yet their mechanistic explanations were short or incomplete (e.g., "small holes in the tree filter air"). While students showed clear plant awareness, likely influenced by hands-on experience, their mechanistic knowledge remained basic. These results suggest that even beginning mechanistic understanding can enhance plant awareness in young learners. The findings highlight the potential for targeted instruction to develop more complete scientific reasoning about plants in early education.

Using machine learning to assess students' responses to evolution scientific explanation questions

Merav Siani, Asaf Salman, Moriah Ariely, Giora Alexandron

and Anat Yarden

| Symposia | 4: Harms: Advancing Evolution Learning – Novel Conceptual and

Methodological Approaches to Evolution Education

Keywords: *Evolution Teaching, Scientific Explanation, Claim-Evidence-Reasoning (Cer), Natural Language Processing (Nlp)*

Submission #: 95

Teaching evolution remains one of the central challenges in biology education, as students often hold persistent misunderstandings of natural selection and fitness, while teachers struggle to address these conceptual gaps effectively. This study investigates 12th-grade biology majors' responses to a national matriculation exam question that required constructing a Claim-Evidence-Reasoning (CER) explanation about fitness in a rodent population. Using machine learning (ML) and natural language processing (NLP), we analyzed 580 open-ended responses to explore how automated approaches can evaluate scientific explanations and reveal conceptual patterns in students' evolutionary reasoning. A team of experts developed and validated the CER-based rubric, capturing the components of claim, evidence, and reasoning. A large language model (DictaBERT) was fine-tuned using stratified 5-fold cross-validation, achieving high reliability (Cohen's Kappa = 0.82, accuracy = 0.94, F1 = 0.91) and strong alignment with expert scoring. Clustering human-graded responses using K-means and DD-weighted gap identified four distinct CER knowledge profiles, each reflecting different levels of conceptual understanding. Findings show that while some students articulated coherent explanations linking fitness to survival and population change, many demonstrated incomplete reasoning, especially about long-term evolutionary effects. The study illustrates how NLP-based assessment, combined with cluster analysis, can extend beyond rubric scoring to diagnose conceptual gaps, providing powerful tools for formative assessment and more targeted teaching of causal reasoning in the context of evolution.

The gemeinsamer fortbildungstag (gft): a transferable model for practice-oriented professional development in digitally enhanced stem teaching

Rebekka Siedler, Stefanie Hartmann, Maren Muth and Steffen Schaal

| Oral |

Keywords: *Process Quality, Professional Learning Groups, Stem, Teacher Training, Teacher Collaboration*

Submission #: 168

This study presents the Gemeinsamer Fortbildungstag (GFT), a resource-efficient professional development opportunity designed to strengthen biology teachers' digitally enhanced STEM teaching. Recent surveys reveal a persistent gap between teachers' participation in digital training and their actual use of digital tools in the classroom. Teachers lack confidence, time, and infrastructure. Research highlights the need for practical, sustainable training formats that integrate theory, application and reflection. The GFT addresses these issues by combining co-constructive teacher training with parallel student workshops at a university of education. Teachers collaborate in Professional Learning Groups (PLGs) to design digital teaching products, guided by Kolb's Experiential Learning Cycle. An initial evaluation of the in-person training (N = 24, 2025) using a standardized questionnaire indicates high process quality, particularly with regard to structure, clarity, collegial exchange and practical relevance. One PLG is being studied in depth to assess the quality of both the process and the product in collaborative processes. In line with Educational Design Research principles, findings from questionnaires, student feedback and teacher interviews will inform the iterative refinement of the GFT concept. We propose that the GFT provides a transferable approach to promote digitally enhanced STEM teaching, professional collaboration and authentic learning experiences. Further analyses will investigate the long-term impact of PLG collaboration on teaching practices, and the model is planned to be extended to other STEM subjects from 2026 onwards.

Public interest in identifying invertebrates in the mirror of social network groups

Veronika Šilhavá and Jan Mourek

| Poster |

Keywords: *Invertebrates, Identification, Social Networks, Public Interest*
Submission #: 243

Groups on social networks focusing on identification of organisms are becomming a popular mean of informal biology education. On the other hand they provide a prospective source of data on public interest for different taxonomic groups of organisms and for particular species. In our research we focuse on public interest for invertebrate animals, which are traditionally believed to receive much less public attention than the vertebrates and often arouse negative emotions. We selected a Czech public Facebook group "Určování bezobratlých" (Invertebrate identification). This public group currently has over 34,000 members, providing them the opportunity to inquire about the identification of animals based on an attached photograph. We analyzed a total of 11,550 posts published during one year (September 2023 to August 2024). Our main objectives were to examine: (i) which invertebrate groups and particular species attract the most attention; (ii) how the interest in identifying these organisms changes throughout the year; (iii) what are the main purposes of asking for the identification of these animals; (iv) whether people express predominantly positive or negative emotions towards them. More than 89% of the questions were asked about the arthropods. Most posts were shared in the spring and summer months, whereas a decline in interest was observed in winter. The most common purpose of asking was the "verification" category, where people asked questions with a pre-formed notion (often incorrect) of which species it might be. Expressions of positive emotions outweighed negative ones and women exhibited negative emotions more frequently than men.

Conceptualizing the educational value of citizen science for fostering scientific and statistical reasoning and nos understanding

Haya Ben Simon, Anna Pshenichny-Mamo and Dina Tsybulsky

| Symposia | 1: Tsybulsky: Transforming Biology and Environmental Education through Citizen Science

Keywords: *Scientific Reasoning, Statistical Reasoning, Nos Understanding, Citizen Science*

Submission #: 45

Today, the public is exposed to vast amounts of information from innumerable formal and informal scientific and social sources with almost as wide a range of reliability. To gauge reliability, individuals must harness three key types of reasoning: statistical (reasoning with data), scientific (relating the data to scientific theories), and understanding the Nature of Science (NOS-how science operates). Cultivating and integrating these forms of reasoning is a priority in contemporary science education but remains under-addressed. This study examined how the citizen science environment can foster these critical reasoning skills by engaging learners in genuine scientific practices. Study`s participants were 15-16-year-old students which take part in “sleep” citizen science project. The learning sequence included four main stages: introduction with scientific background and sleep scientists, collection and analysis of personal sleep data, modelling activities and analysis of national Big Data set. A qualitative deductive and inductive content analysis of classroom discussion transcripts and artefacts showed that the citizen science framework provides multiple opportunities for students to engage in the three types of reasoning. Throughout the learning sequence, students demonstrated increasing ability to interpret multivariable relationships and relate data to scientific theories (scientific reasoning), expressed different types of uncertainty with growing confidence (statistical reasoning), and developed more mature views on NOS aspects such as scientific theories and the tentative nature of science (NOS understanding).These findings highlight the potential of citizen science to cultivate different reasoning types and underscore its value as a pedagogical framework in science education.

Student teachers' perspectives on farm visits – reflections and critical thinking

Pia Sjöblom and Maria Svens

| Oral |

Keywords: *Food Education, Student Teachers, Farm Visits*
Submission #: 227

Learning outside the classroom is crucial in biology and sustainability education. In relation to food production, field visits to various learning sites can add significant value. Several interest groups offer school visits to farms, and teachers play a key role in linking these visits to the curriculum. Teachers must critically reflect on what is presented during a farm visit to provide students with a broad understanding. Consequently, student teachers should be given opportunities to practice these skills during their education. The aim of this study is to examine student teachers' reflections following farm visits. The respondents were 120 second-year student teachers who participated in a field trip organized by an agricultural interest organization. After the trip, the students completed an online questionnaire with open-ended questions. The data were analyzed using thematic analysis. Five main themes emerged from the analysis. The students reflected on the useful information provided during the visit (1), but many perceived the information as partly biased, for example regarding sustainability issues (2). They also reflected on the focus on farmers' position in society, including economic and bureaucratic challenges (3), and emphasized the farmers' extensive knowledge (4). The benefits of locally produced food were also highlighted (5). Guiding student teachers in critical reflection during their studies is essential, as societal perspectives on food production and sustainability are not always self-evident. Further research in this area is needed, as we found limited studies directly comparable to ours.

Problematizing development to foster the understanding of living dynamics: case of sex ontogenesis.

Léna Somano, François Bonneton and Olivier Morin

| Poster |

Keywords: *Ontogenesis, Problematization, Inductors, Obstacles, Sex*

Submission #: 193

In France, ontogenesis is nearly absent from the school syllabus, and seems to be a blind spot in didactics research. However, studying ontogenesis offers interconnections between levels of biological organization, enables students to conceptualize a trait across its history and helps them construct a systemic view of processes. As a consequence, this research explores the problematization of sex ontogenesis as an avenue to foster students' understanding of living dynamics. Indeed, sex ontogenesis is a relevant example for two main reasons. First, this process is representative of living complexity. Secondly, sex is related to social or identity questions that students face outside school, so they may engage easily in questioning and investigating. Furthermore, it is already addressed in the first year of French high school, but without an integrative approach to the continuity across levels of sex manifestation. With the aim of delving into the possibilities for problematizing sex ontogenesis, we adopted an iterative approach and constructed a teaching sequence, later modified in light of the first-year results. Qualitative results from the experiment's first year are currently available. An analysis methodology both qualitative and quantitative is planned for 2025-2026 and will be presented at the ERIDOB conference. Our findings revealed an unthought dimension of development, showing a tendency among students to assimilate development to determination without mentioning differentiation. Here, we also discuss the use of sex-related socioscientific issues as triggers of problematization: if they may unsettle students' initial conceptions, they do not always lead to a scientific reformulation of the problem.

Fostering and linking reflection and research competence among preservice biology teachers

Pauline Sommerer, Helena Aptyka and Jörg Großschedl

| Oral |

Keywords: *Research-Based Learning, Mixed-Methods, Reflection Competence, Research Competence, Preservice Teacher Education*

Submission #: 63

Research-based learning (RBL) is a guiding principle of university teacher education that connects theoretical knowledge with school practice while fostering preservice biology teachers' reflection and research competencies. Reflection, influenced by reflection-related self-efficacy, supports evidence-based teaching by enabling critical analysis of one's own instructional practice. However, preservice teachers often struggle to adopt research-oriented thinking, integrate theory and practice, and sustain motivation. The interrelation between reflection and research competence within RBL, therefore, warrants closer examination. This study explores how integrating student feedback into preservice teachers' research projects fosters reflection and research competence, to provide a deeper understanding of how these key professional skills interact within RBL. This quasi-experimental study examined preservice biology teachers (N = 66; one of two cohorts completed) who participated in master's courses involving the design, implementation, and evaluation of learning activities using student feedback. The experimental group analyzed individualized feedback on their own teaching, while the control group worked with aggregated feedback. Constructs representing reflection and research competences, as well as control variables, were assessed through self-report instruments and content analysis of written reflections. Findings indicate that structured, research-based reflection on student feedback enhances the integration of research activities into written reflections and therefore strengthens the connection between theory and practice. Correlational patterns suggest that reflection and research competence mutually reinforce each other, while stress and limited theory–practice integration may hinder competence development. Overall, the study underscores that RBL, combined with structured feedback-supported reflection, promotes the emergence of a research-reflective professional habitus among preservice biology teachers.

Learning about sea animals through a playful museum educational program

Marios Sotiriadis, Katerina Michopoulou, Efstratios Valakos

and Martha Georgiou

| Poster |

Keywords: *Museum Educational Program, Non-Formal Education, Sea Animals, Playful Learning*

Submission #: 219

This work presents the development and early implementation of a playful educational program designed for the Zoological Museum of the National and Kapodistrian University of Athens. Aimed at students in the third and fourth grade, the program introduces basic ideas about marine life and endangered species through group-based exploration and simple problem-solving tasks. Instead of relying on formal instruction, the activities encourage students to move around the museum, observe animal specimens closely, and work together to complete challenges linked to the exhibits. The core of the program is a "hidden treasure" activity in which each group follows a map, solves short puzzles, and performs small observation tasks that gradually reveal information about marine biodiversity and conservation. The playful structure appears to support engagement, while the museum setting provides a natural space for curiosity and sensory learning. At the end of the session, students complete a brief reflection sheet, allowing them to articulate what they learned and how they felt, and to express intentions for future action related to environmental protection. Initial observations suggest that the program promotes cooperation, empathy toward marine animals, and a growing awareness of conservation issues. These early results highlight the value of museum-based, non-formal learning experiences that blend exploration with emotional and social development.

Biology teachers as change agents - potentials for transfer of digitally-supported scientific inquiry

Ronja Sowinski, Finja Grospietsch and Moritz Krell

| Oral |

Keywords: *Teacher Professional Development, Digitally-Supported Scientific Inquiry, Knwoledge Transfer, Change Agents*

Submission #: 85

Despite a substantial number of studies on effective instructional strategies in biology education, the knowledge transfer of such findings into classroom practice remains difficult. Challenges at both the individual (i.e., limited time, lack of confidence) and systemic level (i.e., insufficient collaboration structures) continue to impede sustainable implementation. Professional development (PD) programs are promising avenues to empower teachers as change agents who can facilitate the uptake of educational innovations in their schools. This study investigates biology teachers' potential to transfer effective instructional strategies regarding digitally-supported scientific inquiry as change agents into classroom and school settings. A PD program was designed focusing on digitally-supported scientific inquiry situated within the context of biodiversity. While this focus provides the context, the study's primary aim is to explore the general mechanisms and conditions that support or impede transfer. Data were collected from 31 primary school teachers and secondary school biology teachers in Germany through a mixed-methods design using questionnaires and results of discussions. Quantitative data were analysed descriptively, while qualitative data underwent qualitative content analysis. Findings suggest that teachers perceive themselves as highly motivated and self-efficient in their role as change agents, yet often face contextual challenges such as time constraints and lack of colleague interest. In response, teachers developed peer-oriented strategies to support knowledge transfer, including micro-training sessions and collaborative use of digital tools. The results highlight the importance of addressing both individual characteristics and school contexts when fostering knowledge transfer. Further research will examine how these factors interact across successive PD cycles.

Implementation and perception of practical work in lower secondary school biology: teachers' insights

Andreja Špernjak and Katja Stanič

| Oral |

Keywords: *Biology Education, Inquiry-Based Learning, Lower Secondary School, Practical Work, Teacher Perception*

Submission #: 179

This study examines the implementation and perception of practical work in biology among teachers in Slovenian lower secondary schools. Practical work is considered essential for developing students' inquiry skills, conceptual understanding, and scientific literacy, yet its implementation often faces systemic constraints. A quantitative survey was conducted among 133 biology teachers, representing about 30% of all lower secondary school biology teachers in Slovenia. The questionnaire addressed teachers' demographic characteristics, perceptions of students' experiences, and their views on the purposes, benefits, and challenges of practical work. Descriptive and inferential analyses (Kruskal–Wallis and Chi-square tests) were used to identify key patterns and differences among respondents. Findings show that teachers highly value practical work for its ability to increase motivation, engagement, and knowledge retention. Students are generally enthusiastic and curious, although their interest may decline when activities require complex reasoning or reflection. Teachers emphasised that practical work promotes active and experiential learning but is often hindered by time constraints, an overloaded curriculum, inadequate facilities, and insufficient technical support. Less experienced teachers expressed greater dissatisfaction with existing curricular materials, indicating a generational shift towards more inquiry-oriented teaching approaches. The study concludes that while teachers recognise the pedagogical importance of practical work, its effective implementation depends on systemic and institutional support. Recommendations include revising the biology curriculum, improving laboratory infrastructure, providing trained technical staff, and strengthening teachers' professional development. These findings contribute to a broader understanding of inquiry-based science education and its challenges in real classroom settings.

Seeing the unseen: augmented reality as a tool for learning biology with live animals

Katja Stanič and Andreja Špernjak

| Poster |

Keywords: *Augmented Reality (Ar), Biology Education, Digital Technology, Educational Material, Pre-Service Biology Teachers*

Submission #: 178

Augmented reality (AR) is increasingly recognised as a valuable tool for science education, offering interactive and immersive learning experiences. While its integration into teacher education is gaining attention, research specifically addressing biology teacher training remains limited. This pilot study addresses that gap by exploring the impact of AR-enhanced materials on pre-service biology teachers' learning. Seven participants from the Faculty of Natural Sciences and Mathematics, University of Maribor, engaged with two versions of custom-developed educational materials focused on the anatomical, physiological, and behavioural characteristics of seven selected animals (snake, spider, frog, snail, grasshopper, mealworm and fish). One version included AR elements via the EyeJack application on school tablets, while the other version was traditional, non-AR. Participants interacted directly with live animals from faculty vivarium throughout the activity, enabling tactile and observational engagement. Analysis of the completed materials revealed that, for six out of seven animal-specific tasks, the AR enhanced version led to more accurate and complete responses. Participants also perceived AR as a valuable pedagogical tool, highlighting its potential to improve teaching quality, foster engagement, and support conceptual understanding through realistic visualizations. Although preliminary and limited in sample size, these findings offer promising insight into the role of AR in biology teacher education and underscore the need for further research with larger and more diverse groups of student.

Drivers of sustainable dietary intentions in adolescents

Freya Steinacher, Theresa Hofstätter and Lena von Kotzebue

| Poster |

Keywords: *Extended Theory Of Planned Behaviour, Nature Connectedness, Sustainable Food Consumption, Education For Sustainable Developement, Youth Behavioural Intentions*

Submission #: 239

Climate-friendly eating is increasingly recognised as a key lever for climate mitigation. Schools offer an important setting in which sustainable orientations can form, particularly during early adolescence when identity and autonomy begin to develop. To examine the drivers of adolescents' sustainable dietary intentions (IES), this study applies an extended Theory of Planned Behaviour (TPB) that integrates cognitive factors with affective–ecological constructs: nature connectedness (NC) and environmental concern (EC). Data were collected from Austrian lower secondary students (N=197). Analyses included descriptive statistics, correlations, and structural equation modelling. Students reported moderately high intention to eat sustainably alongside very positive attitudes and high perceived behavioural control (PBC). Subjective norm (SN) was weaker and largely shaped by family expectations. NC showed moderate levels, while EC was comparatively high. Correlation analyses revealed strong links between NC, attitude, and PBC. The extended model demonstrated good fit and explained 42.9 % of the variance in IES. PBC (β=.28) and attitude (β = .23) were the strongest predictors, followed by SN (β=.13). NC predicted all TPB components and exerted a small direct effect on intention (β=.15). Girls reported higher IES, NC, and EC; grade level showed a negative association with IES. These findings underscore the combined relevance of cognitive and affective–ecological factors in shaping adolescents' sustainable dietary intentions and highlight the potential of school-based strategies that strengthen agency and nature connectedness.

Analyzing gaze behavior and cognitive processes in experts and novices when viewing an animation on pcr

Silke Sterck, Amber Gregoor, Lies Vanden Broeck, Lieve Moeyersons, Bert Oben and Marion Crauwels

| Oral |

Keywords: *Biotechnology, Animations, Eye-Tracking, Multimedia Learning*
Submission #: 150

Polymerase chain reaction or PCR is a widespread biotechnological technique. Even though biotechnology is a broad scientific field, embedded in many aspects of society, it appears to be underrepresented in classrooms. Research into teaching and learning biotechnology should therefore be an important aspect of biotechnology education research. Animations might provide a good way of bringing PCR into the classroom, as they have been shown to be mostly successful for learning complex, dynamic processes. However, research into the effectiveness of animations has gathered mixed results. In this study, we provide insights in the gaze patterns of experts and novices when viewing an animation on PCR, from a subject-didactics point of view, using a mixed-methods approach. By combining data from eye-tracking recordings, retrospective think-aloud interviews, and retention and transfer tests, we discovered that novices constructed a basic view of PCR by describing it as a cyclical process with three stages. Unlike experts, novices were unable to link different events in the animation. As a consequence, they formed a less coherent mental model on PCR. Experts were better at selecting relevant information and integrating different aspects shown in the animation, although they were also not always able to integrate aspects correctly. Our study adds to existing literature calling for the careful design of animations and cues within animations. We further argue that subject-specific research can complement the design of these cues and educational biological animations.

How do pre-service biology teachers construe "adaptation"? eliciting personal constructs using the repertory grid method

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Kostas Kampourakis

| Symposia | 4: Harms: Advancing Evolution Learning – Novel Conceptual and

Methodological Approaches to Evolution Education

Keywords: *Evolution Education, Pre-Service Biology Teachers, Adaptation, Repertory Grid Method, Key Evolution Concepts*

Submission #: 139

In Switzerland, public acceptance and teacher understanding of evolution remain limited despite the strong scientific consensus. Understanding how pre-service biology teachers conceptualize key evolution concepts (KECs) is thus critical for improving evolution education. This study investigates how secondary pre-service biology teachers construe the concept of adaptation using the repertory grid (RG) method, which elicits individual constructs for comparing biological traits. Data collection includes a one-hour RG interview and a questionnaire on evolution acceptance and personal beliefs, administered across French-, German-, and Italian-speaking regions. We present preliminary findings from eight pre-service teachers. Participants rated a range of traits (e.g., beak shape, camouflage, offensive behavior, reproduction) using constructs they generated. The pooled grids were analyzed using principal component analysis (PCA). The first dimension (Dim1) contrasts active traits (e.g., feeding) with traits linked to environmental integration (e.g. concealement), suggesting a functional axis of construal. The second dimension (Dim2) distinguishes reproduction-related or non-adaptive traits (e.g., vestigial wings, floral structures) from more canonical examples of adaptation (e.g., sharp teeth, leaf traps) reflecting a distinction between survival and reproduction. These results suggest that pre-service teachers do not view adaptation as a uniform concept but rather organize it along intuitive and functional lines. Identifying such conceptual patterns provides useful insights into their conceptions and can inform teacher education strategies to address persistent misconceptions and foster a more integrated understanding of evolution.

Navigating current information: an investigation of students' online information-seeking behavior

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| Poster |

Keywords: *Socio-Scientific Issues, Online Information Seeking, Media Literacy, Genetic Engineering*

Submission #: 190

In an increasingly digitalized world, students' ability to critically navigate online information is essential for informed participation in socio-scientific discourse. While educational frameworks such as the European "Digital Competence Framework for Citizens" highlight these skills as important, recent studies reveal significant gaps in students' media literacy. According to PISA 2022, 73% of 15-year-olds believe that they can find learning resources online, but only 51% believe they are able to easily assess the quality of information found online. Our project addresses this lack of media literacy and aims to develop teaching materials that enable students to gather and evaluate online information. Currently, the project examines students' needs during information seeking so that they can be specifically addressed in course materials. Specifically, we employ a mixed methods approach to investigate students' online information-seeking behavior in the context of the socio-scientific issue (SSI) of genetic engineering. A quantitative approach is applied to survey the students' attitude towards the SSI, self-assessed media-literacy, and internet-specific epistemic justification beliefs. Qualitative data is collected through open-ended questions regarding students' sources of information and their ability to judge the credibility of information they find online. During the investigation, students are asked to answer a predefined socio-scientific question regarding genetic engineering and their information-seeking process on this topic is recorded through screen and audio capture. We will present the findings from our exploratory phase at the conference and discuss their implications for the design of teaching materials.

A role for individual-level mechanisms in developing integrated evolutionary explanations

Julia Svoboda, Sugat Dabholkar and Scott Benjamin

| Symposia | 3: Morgenstern: Mechanistic reasoning in biology: Exploring processes, challenges, and educational Value

Keywords: *Mechanistic Reasoning, Evolution, Case Study, Conceptual Change*

Submission #: 90

The mechanisms of evolutionary change occur at the population level. However, prior research has shown that students often reason about evolution at the individual-level, appealing to mechanisms of intentional change or use and disuse. In this study we traced shifts in when and how one student used individual-level mechanisms in evolutionary explanations during an interview. We found that the student used population-level ideas about natural selection to explain the evolution of trait gain, but that individual-level mechanisms arose when the student attempted to explain the evolution of trait loss. However, rather than block this student's ability to reason at the population level, we found that individual-level ideas about trade-offs in resources and energy became integrated into a population-level explanation for trait loss. While prior work has characterized individual-level ideas as barriers to evolutionary understanding, we use this case to argue that students' reasoning across mechanistic levels can be a productive stepping stone. Specifically, such reasoning can help students develop evolutionary explanations that integrate both population-level ideas (how trait frequencies change) and individual-level mechanisms (developmental changes in phenotype) We propose that a main reason this student was able to explore and integrate mechanisms across levels was that the interview created opportunities for the student to reflect on and construct his own understandings rather than recall answers that would satisfy the interviewer. We suggest that making space for students to engage in sense-making in classrooms could support them in constructing and productively integrating biological mechanisms across levels from evolutionary and developmental perspectives.

3d modeling and 3d printing in biology teacher training - problems and solutionstrategies of students

Mahdi El Tegani and Claas Wegner

| Oral |

Keywords: *3D Modeling, 3D Printing, Pre-Service Teacher, Teacher Training, Problem Solving Strategies, Qualitative Research*

Submission #: 225

Although the sophisticated use of models in science teaching is a core competence, biology teachers in particular show weaknesses in the reflective use of models. At the same time, new technologies such as 3D modelling and 3D printing (3DMP) offer opportunities to create professional models that are tailored to the needs of the learning group and the topic. However, the use of such technologies usually fails due to insufficient training and a lack of skills. Although some recommendations for the effective design of training programmes for trainee teachers have already been put forward, further analysis is needed with regard to the problems that arise and solution strategies in connection with 3DMP. To close this gap, the reports of 14 biology teacher training students who attended a seminar on 3DMP for biology lessons were examined. During a five-week independent practical phase, in which the students designed their own 3D model and lesson plan, they kept a weekly diary. These reports were then examined to find out what problems the students reported, how they were able to overcome these challenges, and what factors played a role in this. In particular, using the software and planning the lessons were described as particularly challenging. Meeting their own expectations and quality-driven criteria for models also presented a challenge, among other things. Managing their own time was also found to be challenging. Positive factors for solving problems included collaboration among students, discussions with lecturers, and in-depth exploration of the software through trial and error, for example.

Combining virtual reality and real dissection in biology lessons: effects on cognitive load, interest, disgust, and learning gain

Dorian Thomsen, Dagmar Hilfert-Rüppell and Alexander Georg Büssing

| Oral |

Keywords: *Immersive Virtual Reality, Field Study, Emotions, Cognitive Load, Dissection*
Submission #: 210

The dissection of animal organs, such as pig hearts, is a customary component of biology lessons and is required in numerous curricula for the subject. It enables direct interaction and facilitates the formulation of conclusions concerning phenomena that are not directly perceptible, such as the structure and composition of the heart. Nevertheless, students frequently report a high degree of disgust during such dissections, which can hinder learning. Empirical evidence has demonstrated that combining real and virtual experiments in the classroom promotes learning. Immersive virtual reality (IVR) appears to offer good opportunities for the enhancement of visualization and comprehension, particularly in contexts where direct experience is not feasible. This study therefore examines how combining a learning unit in IVR with a real dissection affects interest, disgust, cognitive load, and learning gains. Furthermore, the study investigates the potential impact of the sequence of tasks on the learning outcomes. Four classes of eight-grade students from a single school participated in the study. The students were either learning about the structure and function of the heart in an IVR learning environment first or engaged in a practical dissection of a pig's heart. Subsequently, the other activity was performed. All learners completed one pre-test and two post-tests (one after each block). The results of the study confirm that the level of disgust experienced during the dissection was notably high and was not significantly mitigated by the preparatory IVR learning unit. In addition, it was demonstrated that the group which initially utilized the VR glasses and afterwards dissected the heart exhibited a higher learning gain than the other group. As the learners were not obligated to respond to all questions, their willingness to complete the questionnaires declined at the end of the day and the second post-test. Consequently, additional classes will be surveyed to achieve the originally targeted sample size at all test times. Nevertheless, these results provide initial indications that preparing for a dissection using IVR is more useful than follow-up work in IVR.

Fostering specific types of knowledge towards more academic success in the introductory phase of biology study programs

Julia-Marie Tocco, Kai Cardinal, Heike Theyßen, Andreas Borowski and Philipp Schmiemann

| Oral |

Keywords: *Prior Knowledge, Introductory Phase, Biology Study Programs, Academic Success*

Submission #: 241

Subject-specific prior knowledge is a crucial predictor of academic learning and success, particularly during the introductory phase of biology study programs. In this context, it is paramount to understand and apply biological core concepts (e.g., Surface Enlargement). This can be represented by specific knowledge types: Knowledge of Meaning (KoM) and Application of Knowledge (AoK). However, students who begin their studies with limited knowledge often struggle to keep pace. This may contribute to high dropout rates. In this study, we investigate whether fostering specific types of knowledge (KoM, AoK) can enhance academic success among first-term biology students. To this end, specific learning environments were developed and tested to promote these knowledge types. An experimental intervention study (N = 134) was conducted with three groups: two intervention groups, each receiving targeted support for one type of knowledge, and one control group without additional support. Knowledge gains were assessed through pre- and post-tests. Academic success was measured via exam performance after the first semester. Results revealed significant differences in knowledge acquisition between the groups. The learning environments prove to be effective in promoting the specific types of knowledge. Students in both intervention groups also achieved higher exam performance than those in the control group, with the KoM group demonstrating the greatest academic success. These findings highlight the effectiveness of targeted, subject-specific learning environments in promoting early academic achievement and reducing dropout risk. Aligning instructional design with distinct knowledge dimensions supports sustainable learning and facilitates students' transition into higher education.

Teacher professionalization programme on plant species conservation at the university botanic gardens ljubljana

Maja Tomšič, Katja Malovrh, Jože Bavcon and Blanka Ravnjak

| Poster |

Keywords: *Botanic Gardens, Teacher Professionalization, Plant Species Conservation, Life Seedforce Project*

Submission #: 73

The University Botanic Gardens Ljubljana plays an important role in promoting knowledge of plant diversity and conservation among various audiences, including educators. On 18 October 2024, we organized a teachers proffessionalization lecture on the topic of plant species conservation for science and biology teachers. The lecture was attended by a total of 27 primary and secondary school teachers. One-day lecture was one of the actions of project Life seedforce. The programme included a presentation of Life seedforce project, a lecture on plants and nature conservation, a session on the inclusion of the subject in the educational process, a guided tour of the Botanic Gardens and demonstrations of classroom activities that teachers can use when teaching this topic. At the conclusion of the programme, participants completed an evaluation questionnaire to share their opinions about the statemets. We applied a quantitative research technique and used a Likert rating scale to measure the attitudes and opinions. The participants indicated their level of agreement with the different statements about plant conservation topic. The results indicated a high level of agreement among teachers that it is important to introduce plant conservation in the classroom.

Beyond the classroom: biodiversity in action

Gregor Torkar and Špela Klofutar

| Poster |

Keywords: *Early Childhood Education, Outdoor Education, Forest, Biodiversity*

Submission #: 117

This study investigates the impact of direct versus vicarious experiences with forest organisms on Slovenian preschool children's biodiversity knowledge. A total of 129 children aged three to six participated in one of three conditions: a week-long, outdoor forest program; a classroom-based instructional program; or a no-intervention control group. Both instructional approaches addressed knowledge of forest animals, and general forest ecology. Using a quasi-experimental design with pre-test, post-test, and six-week follow-up assessments, the study found that children in the forest program demonstrated the largest and most sustained learning gains across all domains. Classroom instruction produced smaller and often temporary improvements, whereas the control group showed minimal change. These findings highlight the effectiveness of sensory-rich outdoor learning in fostering detailed and enduring biodiversity knowledge, broadening children's ecological awareness beyond charismatic fauna.

Teachers as agents of change: motivation and agency for teaching climate change

Cigdem Han Tosunoglu, Justus Schöller and Annette Upmeier

Zu Belzen

| Oral |

Keywords: *Climate Change Education, Teacher Agency, Self-Determination Theory, Biology Teachers*

Submission #: 24

Climate change education aims to equip learners with the knowledge, skills, and values needed to respond responsibly to environmental challenges. Teachers play a central role in this transformation, yet many face structural, pedagogical, and emotional barriers that limit their ability to teach climate-related topics effectively. Studies show that climate change education often relies on teachers' personal motivation and that educators struggle to balance factual accuracy with emotional sensitivity in the classroom. In Germany, motivation and self-efficacy are decisive factors influencing the extent to which sustainability is addressed in schools. This study explores biology teachers' psychological and motivational orientations toward climate change education in Germany through the frameworks of Self-Determination Theory and the Ecological Model of Teacher Agency. It examines the constructs of hope, worry, interest, teaching agency, and self-efficacy, asking: (1) To what extent do teachers differ in these dimensions? and (2) How do they experience and interpret them in professional practice? Using a convergent mixed-methods design, quantitative data were collected from 15 teachers through validated scales, and qualitative data from 13 interviews, six of which have been analyzed so far. The results show high motivation but moderate levels of self-efficacy and agency, while qualitative findings reveal limited competence, restricted autonomy, and the supportive role of collegial collaboration. Overall, the study underscores the need for professional development programs that enhance teachers' competence, autonomy, and collaboration to strengthen their agency in climate change education.

Exploring how the concept “adaptation” is defined in scientific articles using text mining

Lucie Tournayre, Nikos Tsourakis and Kostas Kampourakis

| Symposia | 4: Harms: Advancing Evolution Learning – Novel Conceptual and Methodological Approaches to Evolution Education

Keywords: *Adaptation, Evolution, Text-Mining, Llm*

Submission #: 77

Adaptation is a key concept in evolutionary biology and is frequently referenced in scientific literature. In the PLOS journals alone, more than 130,000 articles mention “adaptation.” Our first objective is to explore how this concept is defined in scientific articles and to characterize the range of definitions used. Given that articles in scientific journals usually do not provide explicit definitions of concepts, we will rely on a semantic analysis to infer the intended meanings. Our second objective is to investigate how the semantic use of adaptation has changed over time. To address these questions, we compiled a dataset of 7,154 articles from the journals PLOS Biology and PLOS Genetics containing the term “adaptation” in the body text and extracted 44,446 sentences with at least one occurrence of the root “adapt.” Using text-mining methods such as co-occurrence analysis and LLMs knowledge-graph construction, we aim to identify recurring terms associated with “adapt” and use them to establish definitional categories. We will then use the OpenAI API to automatically classify all occurrences in the corpus. This classification will enable us to quantify and visualize how the use of each definitional category has evolved over time.

How is “ancestry” conceptualized in the journal plos genetics?

Lucie Tournayre, Nikos Tsourakis, Nuno Ribeiro Galheto,

Alicia Sanchez-Mazas, Mathias Currat, Jose Nunes and Kostas

Kampourakis

| Symposia | 4: Harms: Advancing Evolution Learning – Novel Conceptual and

Methodological Approaches to Evolution Education

Keywords*: Ancestry, Adaptation, Llm, Text-Mining*

Submission #: 78

Ancestry is a key concept at the intersection of biology and identity, sometimes carrying persistent misconceptions. This study investigates the representation and evolution of the concept of “ancestry” in PLOS Genetics from 2005 to 2025. We combine computational text-mining techniques with large language models (LLMs) to analyze a corpus of 15,758 sentences containing mentions of its stemmed form “ancest” across 1,176 open-access articles. A set of definitional criteria, that distinguishing genealogical ancestry (cultural, historical, or lineage-based) from genetic ancestry (quantitative estimates or DNA-based evidence), was developed by experts and manually applied to a subset of 200 sentences. We then tested three LLM-based categorization approaches using the OpenAI API, evaluating consistency and alignment with our manual categorization. Results show that while simpler categorization schemes improve in-between runs consistency, overall agreement with human coding remains low, highlighting challenges in automating nuanced conceptual categorizations. Applying the most reliable approach to the full corpus reveals a temporal trend with genealogical references to ancestry decreasing over time, whereas genetic references increase, suggesting a shift toward quantitative and molecular framings in scientific literature. These findings demonstrate the potential of integrating computational linguistics to study the semantic evolution of biological concepts across scientific literature. Future work will use collocation analysis and knowledge graphs to further refine the definitional categories embedded in the corpus.

Main: transforming biology and environmental education through citizen science

Dina Tsybulsky and Tali Tal

| Symposia | 1: Tsybulsky: Transforming Biology and Environmental Education through Citizen Science

Keywords: *Citizen Science, Biology Education, Environmental Education*

Submission #: 102

Citizen science is a research approach that actively involves non-scientists in authentic scientific investigations. It enables collaboration between research institutes, organizations, and the public, fostering partnerships that advance scientific knowledge and public engagement with science. There are currently hundreds of research studies originating from various scientific institutes and universities worldwide that are being conducted in cooperation with citizen scientists. In recent years, accumulating evidence has highlighted the transformative power of citizen science in education, demonstrating its potential to break down traditional barriers between science and society. Citizen science is now considered an educational practice with significant pedagogical potential. This symposium provides a comprehensive overview of the role of citizen science in transforming biology and environmental education. Featuring contributions from leading experts in the field, it presents evidence-based studies and practical applications that offer valuable insights into the effective design, implementation, and evaluation of citizen science initiatives. Overall, this symposium showcases how citizen science initiatives can enhance students' scientific reasoning and understanding of the nature of science, promote environmental awareness, and foster a deeper connection between individuals and their surroundings. By involving students and community members in real-world scientific investigations, citizen science not only contributes valuable data to scientific communities but also empowers participants to become informed and active citizens. The symposium is based on a recently published book, with the symposium organizers serving as the book's editors and the presenters as contributing authors of its chapters. The book is part of the Springer series on biology education research associated with the ERIDOB research community. The symposium will include: ● Introduction and rationale ● Five presentations: 1. Presentation 1 presents Flebocollect, a citizen science project that engages students in studying the spread of leishmaniosis disease, which links ecosystem alterations to global health challenges. 2. Presentation 2 presents case studies demonstrating how field-based citizen science projects enhance ecological literacy and inquiry-based learning, and offers evidence-based recommendations for educators. 3. Presentation 3 illustrates the pedagogical potential of citizen science to develop scientific reasoning, statistical reasoning, and an understanding of the nature of science. 4. Presentation 4 introduces the concept of expansive framings in citizen science and shows how well-designed projects can cultivate student agency, critical thinking, and deeper engagement with scientific inquiry. 5. Presentation 5 explores the critical role of teachers in citizen science

implementation by identifying the key competencies and institutional supports needed for successful integration. ● Q&A, interaction with the audience

Promoting systems thinking: the effects of instructional guidance in the combined use of digital system models

Nico Tuncel, Rieß Werner and Maik Beege

| Oral |

Keywords: *Systems Thinking, Climate Change Education, Modeling, Digital Learning Environment, Problem-Solving Prior To Instruction*

Submission #: 33

Promoting systems thinking is a key objective of Education for Sustainable Development (ESD), as it enables learners to understand complex interdependencies and to develop strategies for addressing global challenges such as climate change (UNESCO, 2017). Previous research has shown that combining qualitative and quantitative system models such as causal loop diagrams and computer simulations can foster systems thinking (Brockmüller & Siegmund, 2020; Rieß, 2013). However, the underlying learning processes, particularly how different forms of instructional guidance affect learners' engagement with system models, remain insufficiently understood. This study investigates how conceptual and strategic guidance influence students' acquisition of systems thinking when engaing with digital causal loop diagrams in conjuction with the climate simulation En-ROADS. In a 2×2 experimental design with students in grades 9 and 10, participants first created an initial causal loop diagram during an exploratory phase and subsequently revised it under varying guidance conditions. Data include pre- and posttests on systems thinking and climate knowledge, measures of cognitive load, and coded analyses of diagram refinements as indicators of generative learning processes. Pilot results (N = 63) indicate that conceptual guidance alone yielded the greatest increase in network complexity within causal loop diagrams, whereas the combination of conceptual and strategic guidance appeared to attenuate this effect potentially due to cognitive overload or interference between guidance types. These findings underscore the necessity of finely tuned, adaptive insturctional guidance in simulation-based learning and provide important implications for the design of digital learning environments that aim to promote systems thinking in biology education.

Developing preservice teachers´ systems thinking by elaborating networks of ideas

Araitz Uskola

| Poster |

Keywords*: Systems Thinking, Preservice Teachers, One Health*

Submission #: 12

Systems thinking (ST) allows students to address complex problems in science classrooms. ST is considered a competence that requires identifying the elements that are part of a system, as well as the relationships between them and deciding how to act on it, capacities that are demanding for students. Some strategies that are used for addressing them are modellling activities and the use of diverse representation modes such as concept maps. "One Health" notion is a notion that inherently requires ST. This study addressed what level of ST did 56 primary pre-service teachers (PSTs) engaging in activities about antibiotic resistance show throught the teaching-learning sequence that included the reading of texts, the construction of an ideas´ network and the proposal of actions. The results show that the sequence of activities was successful in promoting the development of ST by the PSTs, especially in the case of ST-Components and ST-OrgBeh dimensions. The results of the group activities showed that for the first dimension, the activity of reading texts was the determining factor for change, while in the case of the most complex dimension, ST-OrgBeh, it was necessary to create the subsequent network of ideas. The perspective of viewing oneself as being part of the system yielded unclear results, as it cannot be said that a clear development was observed. This may indicate a problem in several ways. The educational implications are discussed.

It's a paradox – pre-service biology teachers' perspectives of culture-based socio-scientific issues

Aprillyana Dwi Utami, Andri Christodoulou and Marcus Grace

| Poster |

Keywords: *Pre-Service Biology Teachers, Cultural Diversity, Socio-Cultural Perspectives, Socio-Scientific Issues*

Submission #: 156

Socio-scientific issues (SSI) have been employed over the last two decades to promote scientific literacy. In teaching SSI, teachers need to consider students' socio-cultural background, as their initial knowledge and decision-making can be influenced by their cultural beliefs. SSI that incorporates cultural dimensions is called Culture-Based Socio-Scientific Issues (CBSSI). A CBSSI is one in which the controversy is heavily centred on culture and involves science and other aspects that can potentially impact society. Competent teachers are required to deliver SSI lessons. Many studies have reported on how to prepare pre-service teachers and how they perceive teaching SSI. However, research on how pre-service biology teachers (PBTs) perceive CBSSI and how it can be taught is underexplored. This study aims to uncover PBTs' perspectives on CBSSI and how it can be taught. A qualitative study is used for this research, which consisted of a CBSSI training programme followed by individual semi-structured interviews. Data are collected through training reflections, observation notes, lesson plans, and individual semi-structured interviews. All the data were analysed using thematic analysis to identify key patterns of PBTs' perceptions of CBSSI and how to teach them. The study reveals that PBTs viewed CBSSI as a unique blend of science and culture, acknowledging its controversial nature. Despite intending to remain neutral, many PBTs lean towards a scientific perspective. PBTs also foresee some benefits and challenges in teaching CBSSI. This study offers a theoretical contribution by providing insights into PBTs' perspectives on CBSSI and how it can be taught.

Fostering systems thinking and interdisciplinary understanding of photosynthesis through design-based learning in lower secondary education

Katrin Vaino, Konstantinos Korfiatis and Ana Valdmann

| Oral |

Keywords: *Design-Based Learning, Systems Thinking, Photosynthesis*
Submission #: 236

This study examines how design-based learning (DBL) can support lower-secondary students in developing interdisciplinary understanding of photosynthesis and elements of systems thinking. While DBL is known to promote conceptual engagement and iterative reasoning, less is understood about how it can simultaneously foster core scientific understanding and systems-oriented thinking in early secondary science. Seventy-six eighth-grade students from two schools, supported by three teachers, participated in a three-week learning scenario in which they designed a mini-greenhouse for growing herbs during the winter. The scenario integrated ideas from biology, physics, chemistry, and technology education through simulations, inquiry activities, and collaborative design tasks. Students were introduced to foundational systems-thinking notions, including identifying subsystems, recognising key variables, and considering how changes in one component affect the behaviour of the whole system. Structured whiteboarding discussions enabled groups to share emerging ideas, compare representations, and provide peer feedback. Data included students' initial, post-inquiry, and final design prototypes, each accompanied by written explanations. These artefacts were analysed using qualitative content analysis to trace how students represented system components, disciplinary relationships, and interactions. Semi-structured teacher interviews, analysed using the same approach, offered complementary insights into instructional demands and perceived benefits. Findings show that students' early designs were predominantly linear and fragmented, focusing on isolated variables and descriptive accounts of greenhouse functioning. Over time, many produced more integrated representations that attended to interactions among light, temperature, humidity, airflow, and plant processes, demonstrating emerging systems thinking. Teachers valued the scenario for helping students connect disciplinary ideas and make their reasoning visible, while noting challenges in balancing open-ended exploration with timely guidance. Overall, the study highlights how DBL can provide productive conditions for interdisciplinary learning and the development of systems thinking in lower secondary science.

Motivation, preparation, and learning strategies in the estonian biology olympiad: a comparative study between basic and upper secondary students

Ana Valdmann

| Poster |

Keywords: *Motivation, Biology Olympiads, Learning Strategies*
Submission #: 14

Academic Olympiads play a crucial role in Estonia's education system, fostering excellence and sustained interest in scientific disciplines. This study examines differences between basic and upper secondary school students in motivation, preparation strategies, and perceptions of task difficulty in the Estonian Biology Olympiad. In the 2024 regional round, 1,242 basic school and 690 upper secondary students participated, with 707 (57%) and 261 (38%) responding to the survey respectively. Findings show that teacher recommendations and curiosity are dominant motivators among basic school students, while upper secondary students display stronger intrinsic and career-oriented motivation. Preparation is largely self-directed but differs in timing and resource use: younger students depend on textbooks and teacher guidance, whereas older students use more diverse materials, including scientific journals and university-level sources. These findings highlight the Olympiad's dual role as a learning environment that supports both early scientific curiosity and advanced independent learning.

Students' engagement with argumentation in mendelian genetics: two-dimensional automated assessment

Malka van Dijk, Moriah Ariely, Asaf Salman, Giora Alexandron and Anat Yarden

| Oral |

Keywords: *Argumentation, Automated Assessment, Genetics*

Submission #: 211

Argumentation is recognized as a core scientific practice, yet assessing students' written arguments remains a persistent challenge. This study explores the potential of large language models (LLMs) to evaluate students' scientific argumentation in the context of Mendelian genetics. Building on prior work in automated assessment, the study employs both fine-tuned Hebrew BERT models (DictaBERT) and few-shot prompting (ChatGPT-4o) to score 615 randomly selected open-ended responses from the Israeli Biology matriculation exam. A binary analytic rubric was developed and validated through expert scoring. Results show that both automated approaches achieve strong alignment with human ratings ($\kappa = 0.63–0.99$), with ChatGPT-4o performing comparably to fine-tuned models despite requiring no training. Cluster analysis of the scored responses identified six clusters organized into three overarching profiles: (1) correct claims supported by appropriate evidence; (2) correct claims incorporating inappropriate evidence; and (3) incorrect claims based on misconceptions about dominance and inheritance. Notably, only about 10% of responses included rebuttals, highlighting the rarity of advanced argumentation. The findings demonstrate that both automated approaches can reliably identify students' responses, offering promising pathways for formative feedback in science education. In addition to its methodological contribution, it revealed distinct patterns of argumentation within the context of Mendelian genetics through a two-dimensional assessment approach, linking students' conceptual understanding with the quality of their argumentative reasoning.

Collective over individual? patterns of action competence development through a climathon

Michiel van Harskamp, Marinthe Meijer, Marie-Christine P.J. Knippels and Jelle N.A. Boeve-de Pauw

| Oral |

Keywords: *Action Competence, Action Orientation, Assessment, Learning Outcomes, Sustainability And Climate Change Education*

Submission #: 126

Action competence is one of the key learning outcomes for sustainability education in recent years. An action competent individual has knowledge of action possibilities, confidence in their influence, and willingness to act. Despite this, not a lot of scholarly attention has gone to how such action-oriented education can look in practice, and if and how such educational approaches foster the development of action competence in learners. The objective of this study is to assess to what extent the Young Innovators Climathon fosters action competence, thereby improving our understanding of features of programmes that enable this. This activity has been selected for its action-oriented nature. Pre-post survey data with closed and open questions were collected at five different secondary schools in the Netherlands which participated in the Young Innovators Climathon programme. We collected paired pre-test and post-test data from 107 students (14-18 year old; 49.5% identified as female, .9 % as different). The paired Wilcoxon Signed-Rank Test shows that students' overall action competence at the post-test was significantly higher compared to the pre-test. Willingness to act subcomponents grew more frequently than Knowledge of action possibilities. For Confidence in own influence, two out of four subconstructs grew significantly in the post-test. Effect sizes were between medium and large. Overall, subconstructs tapping into collective rather than individual aspects of action competence more often improved in the post-test. This study shows that by adopting an action-oriented approach, students can develop important facets of action competence through sustainability education. Incorporating real-world actions and democratic participation of students in the learning process fostered student willingness to act and confidence in their influence. For the current programme, this was mainly focussed on collective rather than individual problem solving and action taking. By incorporating an action-oriented approach, biology education can hereby prepare students for effective sustainability actions that promote necessary green transitions.

Students' satisfaction with a waste-management event: an evaluation of the "waste competition"

Dagmar Vašutová

| Poster |

Keywords: *Pro-Environmental Programme, Outdoor Education, Waste Competition*
Submission #: 122

This study presents the results of an environmental education event focused on students' attitudes toward waste management. The programme was held between 2024 and 2025 and involved primary school students. A questionnaire using five emoticons operationalized as a five-point ordinal Likert-type scale was applied to measure the level of students' satisfaction and their willingness to engage in waste-related behavioural change. Lower values indicated more positive emotional responses and stronger agreement with decision-oriented statements. Descriptive statistical analysis, including frequency distributions and mean scores, was conducted using MS Excel. The overall mean scores across the three events were 2.03 (Event 2024), 2.16 (Event 2025a), and 1.90 (Event 2025b), suggesting a predominantly positive evaluation of the events. The most positive responses were consistently associated with the item related to cooperative work with friends (1.78), indicating that peer collaboration may serve as an important motivational factor. In contrast, the highest score (2.47) was recorded for the item addressing potential behavioural change in waste management, which may reflect that some students were already sufficiently engaged in pro-environmental behaviour before the intervention. Gender and grade-level comparisons showed only minor differences. Girls expressed more positive attitudes across all items, and younger students (5th grade) provided slightly more favourable evaluations than older ones (6th grade). Overall, the findings indicate that the intervention supported students' positive attitudes toward waste-related environmental issues, with social and collaborative elements contributing significantly to their engagement. The results highlight the importance of participatory learning approaches in environmental education and provide useful implications for the design of similar programmes.

One goes extinct, one evolves: how 3rd graders reason about past and future evolutionary scenarios (symposium: evolution education in the early years)

Lucía Vázquez-Ben, Anxela Bugallo, Patrícia Pessoa, Neil Gostling, Nausica Kapsala, Deborah Kelemen, Ross Nehm, Giulia Realdon, Alexandra Moorman and Xana Sá-Pinto

| Symposia | 5: Pessoa: EVOLUTION EDUCATION IN THE EARLY YEARS

Keywords: *Primary Education, Anticipatory Competence, Evolution Literacy, Previous Conceptions*

Submission #: 248

Citizens must respond to the urgent environmental crisis and to attempts to undermine trust in scientific knowledge. Schools must prepare students to be fully empowered citizens, capable of thinking critically and making informed decisions in the face of these problems. Given the central role of evolution in shaping biological systems, evolutionary literacy is fundamental to this anticipatory competence. Research has shown that children can develop this evolutionary literacy, and should begin developing it as early as primary school, or even pre-school. This paper explores how third-grade students (aged 7-8 years old) can use key concepts of evolution to reason about the past and make predictions about the future. For this purpose, we used a questionnaire developed under a shared project and piloted in different European countries (Germany, Greece, Italy, Portugal, and Spain). Following a deductive-inductive approach, we also designed a specific framework for conducting content analyses of the data. As in previous studies, findings show that many of these young students are already capable of recognising differential survival and/or differential reproduction due to selective pressure. Likewise, they are familiar with some evolutionary terminology, such as “evolution”, or “extinction”, although they are usually employing it from a “lamarckist” (teleological) perspective. Only two of the 22 participants addressed the task from a solely developmental mindset. In this sense, both the questionnaires and the scenarios presented might be a good resource for either teaching or researching, although some adjustments –to both the questionnaires, and the framework– need(ed) to be made.

Analyzing biology textbook question design and student learning outcomes in kosovo classrooms

Zeqir Veselaj and Besiana Gashi

| Oral |

Keywords: *Biology Education, Revised Bloom'S Taxonomy, Textbook Analysis, Learning Outcomes*

Submission #: 93

This study examines the end-of-lesson questions in ninth-grade biology textbooks used in Kosovo and evaluates their alignment with the Revised Bloom's Taxonomy (RBT) as well as the cognitive domains and contexts defined by the Programme for International Student Assessment (PISA). A secondary aim is to assess ninth-grade students' knowledge through questions designed according to the RBT hierarchy, derived from the analysed textbooks. A quantitative research design was employed, combining content analysis of end of lesson textbooks and a student learning outcomes survey. The content analysis encompassed 327 end-of-lesson questions drawn from two nationally approved biology textbooks, while the survey was conducted with 150 ninth-grade students from two lower secondary schools. The analysis revealed a pronounced lack of practical, real-world questions and tasks that could enhance students' engagement and facilitate the application of scientific knowledge in everyday contexts. Most of questions were open-ended, with very limited representation of alternative formats such as multiple-choice, fill-in-the-blank, graphical representation, matching, or problem-solving tasks. Most questions were positioned within the lower cognitive categories of the RBT framework, where students exhibited comparatively higher performance. These findings correspond with the persistently low achievement of Kosovar students in the past three PISA science tests. The findings suggest that the analysed textbooks insufficiently integrate authentic, context-based, and higher-order cognitive tasks that would promote scientific reasoning of Kosovar students and the transfer of knowledge to real-life situations. Enhancing textbook question design in line with RBT and PISA frameworks could improve both student engagement and performance in biology education.

Enhancing motivation in biology and pre-service teachers' professional identities through aesthetic approaches

Nanna Villumsen and Camilla Blomgreen

| Poster |

Keywords: *Motivation, Aesthetic Approaches, Gender*

Submission #: 100

The Danish LEARN project investigates motivational orientations in science among pupils aged 13–16. Prior research shows that pupils' interest in science often declines throughout schooling and that a notable gender gap persists. Cross-national studies further reveal substantial variation in the size of the STEM gender gap, and it has been suggested that in economically prosperous countries, identity affirmation may become more influential in subject choice than financial considerations. While motivation in upper secondary science education has been studied in Denmark, little is known about motivational orientations among younger pupils. Drawing on expectancy-value theory, this large-scale project aims to understand the barriers and drivers shaping participation and motivation in lower secondary science. The project employs a mixed-methods design, combining classroom observations, a 23-item survey, and semi-structured group interviews. A central component of the project is engaging pre-service biology teachers in interpreting and discussing the empirical findings. They were also introduced to motivational theory and collaborated with the research team to co-interpret data and design motivating science activities. Our data indicate notable gender differences in certain motivational aspects but also show that science motivation is multifaceted and cannot be reduced to binary patterns. Both the empirical data and discussions with pre-service teachers highlight the potential of aesthetic learning processes to create safer and more inclusive spaces for science participation. Finally, the study demonstrates that involving pre-service teachers as co-interpreters of large-scale data can meaningfully support the development of their professional identities as future biology teachers.

Students' conceptions of (pollen) allergies: exploring ideas and knowledge levels in secondary biology education

Lisa Virtbauer, Lena von Kotzebue, Johanna Rehrl, Sabrina Wildner and Gabriele Gadermaier

| Poster |

Keywords: *(Everyday) Conceptions, Conceptual Change, Allergies, Pollen*
Submission #: 206

This study, conducted within the Sparkling Science project "DIAG_NOSE", investigates secondary students' conceptions of (pollen) allergies. The project follows an interdisciplinary, citizen-science-based approach linking molecular biology research with biology education to improve allergy diagnostics and understanding of learners' ideas about allergic reactions. Everyday conceptions are known to be persistent and may hinder the acquisition of scientific concepts, especially when new information conflicts with existing cognitive structures. As research on students' conceptions of allergies is limited, this study addresses an important gap. A mixed-methods design was used. Quantitatively, students' prior knowledge was assessed with a 14-item multiple-choice test on immune responses and allergic sensitization and a 9-item scale measuring academic self-concept regarding allergies (α = .79). Qualitatively, students' drawings were analyzed using Mayring's (2015) qualitative content analysis to identify structural and functional conceptions and misconceptions. The study also examined whether personal allergy experience predicted knowledge. The pilot sample included 195 students (M = 12.55 years). For 79%, allergies had not yet been taught in school; 44.6% reported having an allergy. Results showed low to moderate levels of both self-assessed knowledge (M = 2.84) and objective knowledge (M = 3.15). Personal allergy experience did not significantly influence knowledge. While most students identified allergens and symptoms, internal physiological mechanisms were depicted in only 4.6% of drawings. Overall, the findings suggest predominantly surface-level understanding and limited insight into underlying biological processes. The results highlight the need for instruction that explicitly considers learners' conceptions to support meaningful conceptual change. Data collection for the main study is ongoing.

Students' meaning-making in ecology education

Hanna Wanselin and Kristina Danielsson

| Oral |

Keywords: *Multimodal Texts, Group Work, Ecology Education*

Submission #: 41

Ecology is a field that involves complex processes and relationships, which present challenges for students due to its abstract content and the complexity of expressing it. Science relies on multimodal communication, which can support meaning-making but also present representational challenges. This presentation synthesises findings from three studies exploring students' meaning-making in ecology through multimodal text creation. The first study developed an analytical framework based on Systemic Functional Linguistics (SFL) to examine how scientific meaning is expressed. The second applied this framework to ecology education, revealing how students represent ecological processes. The third study analysed students' collaborative discussions during text creation. Data were collected in secondary biology classrooms, where students worked in groups on an ecology assignment involving food webs. Their multimodal texts combined written, drawn, and symbolic elements. Analyses focused on scientific content and representation strategies, both through multimodal texts and surrounding discussions. Findings show that students used various strategies to express ecological relationships and that they faced challenges with abstract processes, e.g., decomposition. Their discussions revealed an awareness of how different modes can shape meaning and how choices in both text and talk can influence how they appear. Students positioned themselves as knowledgeable through disciplinary language while also incorporating creativity through elements of humour, personal experiences, and humanity. These studies highlight the pedagogical value of multimodal text creation, not only for assessing scientific understanding but also for fostering representational skills. The studies suggest that science education should more explicitly address how content is expressed, which can support students' meaning-making.

Shifting between mechanistic and narrative reasoning – towards a dynamic view of cognitive construals?

Karen Waskewitz and Michal Haskel Ittah

| Poster |

Keywords: *Scientific Reasoning, Narration, Cognitive Construals, Climate Change*
Submission #: 88

While the ability to reason scientifically is widely regarded as one of the key competencies for addressing the challenges of our modern society, we must recognize that students have difficulties in constructing scientific explanations and instead often rely on intuitive ways of thinking – recently described as cognitive construals. While associated with biological misconceptions these construals fulfil a heuristic function within the sense-making process of students and may represent another mode of reasoning: the narrative mode (as opposed to the scientific mode of reasoning). This study investigates how junior high school students reason about a climate change related phenomenon. Specifically, it examines how narrative and scientific modes of reasoning are represented in students' initial explanations, and how these modes interact during the sense-making process. In this context, particular attention is given to the role of cognitive construals in students' reasoning. Findings indicate that when students explain a biological phenomenon, they rely on both scientific and narrative modes of reasoning and are able to switch between them. The mode of reasoning is defined by the pattern of causality the student applies and can be identified when switches between the modes occur. Cognitive construals can indicate narrative shifts and function as a narrative place holder for those parts in the over-all account that the student is not sure about regarding the how.

Integrating social justice in biology education: exploring health disparities in diabetes

Pirchia Tamar Waxman, Dana Sachyani, Areen Khalaily, Ravit Golan Duncan, Shoshna Herman, Moran Shalom, Bili Friedman and Michal Zion

| Poster |

Keywords: *Social Justice, Professional Development, Socioscientific Issues, Health Education*

Submission #: 167

This study examines a professional development (PD) program designed to support secondary school science teachers in integrating social justice (SJ) into their teaching. The program focused the phenomenon of health disparities in diabetes and addressed core content for 9th-grade biology: genetics, nutrition, and the digestive system. In Israel, diabetes prevalence varies significantly between communities living in geographically central verses peripheral locations, making it a meaningful entry point for exploring equity-related issues in the context of science classrooms. To investigate how teachers define SJ and how they integrate it into science teaching, we collected multiple sources of qualitative data: pre- and post-PD surveys, final reflective assignment, and semi-structured post interviews. The analysis revealed that teachers' definitions of SJ focused on three dimensions: who is impacted by inequities, responsibility for promoting equity and justice, and how injustice is manifested in society. Regarding classroom practice, two categories emerged: content domains addressed, and teaching approaches employed. Findings revealed several challenges in terms of both teachers' conceptualization of SJ and their perceptions of whether and how SJ issues should be addressed. The initial implementation of the PD did not lead to statistically significant gains in teachers' understanding of SJ, however, there were clear trends indicating nascent shifts towards developing sociopolitical awareness and willingness to contend with the difficulty of discussing controversial and politically oriented topics. Our findings also point to important implications for improving the PD to enhance the focus on understanding the structural entailments of injustice.

Soil health education in austria: topics, challenges and needs. a case study

Lucas Weinberg, Johanna Nagl, Lena Warrelmann and Suzanne Kapelari

| Poster |

Keywords: *Soil Health Education, Soil Literacy, Environmental Education, Climate Resilience*

Submission #: 182

Soils are the foundation of life, as they provide the basis for nutrition, support biodiversity, and act as a natural filter for water. Today, traces of soil pollution and degradation are becoming increasingly visible. However, the complexity and broad scope of the topic present challenges in soil education and lead to the problem that it is only insufficient within certain educational subjects. The LOESS project aims to gain insight into the current state of soil health education within European curricula. In this case study we aim at describing the current implementation of soil education in Austrian curricula. To this end, a focus group discussion with five educators from different educational levels and ten semi-structured interviews were conducted. Both data sources were analyzed using qualitative content analysis to describe the current situation and identify challenges, as well as educators' wishes and suggestions for improving soil education and in this end students' soil literacy. The findings provide valuable insights, revealing a lack of in-depth teaching about soil and, in particular, an absence of explicit soil health education across curricula. The study highlights the importance of integrating "soil health" as an independent subject within the curriculum, as other environmental and sustainability topics can build upon this foundational understanding.

Biodiversity education and species knowledge – german primary school children's conceptions about birds

Annkathrin Wenzel and Eva Gläser

| Poster |

Keywords: *Esd, Students' Conception, Birds, Species Knowledge*

Submission #: 35

Knowledge of species is a fundamental basis for understanding natural connections. Therefore, biodiversity education is also closely linked to the teaching of species knowledge, especially since it has been empirically shown that greater species knowledge leads to greater respect for nature. Studies in Germany on species knowledge of birds in particular underline that species knowledge has declined even further in recent years. However, almost exclusively adults and adolescents have been questioned to date. In addition, previous studies have focused on knowledge about birds in a narrow sense. The present study expands on the current state of research. The central research question is: What species knowledge do German primary school students have about birds? In this qualitative research project, primary school children were specifically interviewed using guided interviews (N ≈ 60). The interviews were based on an expanded understanding of species knowledge, known as species literacy. The Primary school students' answers reveal significant differences in their knowledge of animal species. The results are consistent with other studies in this area, as most of the Primary school students surveyed know very little about bird species in particular. Furthermore, it is becoming clear that not all students are able to establish a basic connection between individual animal species (birds) and the ecosystem. One conclusion that can be made from this is that knowledge about animal species should be linked to biological classifications, ecosystems and thus ESD in primary education so that unconnected facts about individual animal species are not taught in primary school.

Promoting nature connectedness through guided self-reflection on nature-based activities among secondary school biology students

Sören Werner and Marcus Hammann

| Poster |

Keywords: *Nature Connectedness, Human-Nature Connection, Self-Reflection, Pathway-Based Activities In Nature, Extinction Of Nature Experience*

Submission #: 136

A loss of primary experiences with nature can be observed in adolescent learners aged approximately 13-15 years, so there is great interest in the research approach presented here, which aims to promote the human-nature relationship more strongly in biology lessons at the lower secondary level. The aim of the study is to create a framework for biology teachers to make their students' connection to nature more sustainable and to shape it as an environmental psychological attitude, for example through field trips with self-reflective elements. As a first step in the study, a reflection tool will be developed that is suitable for reflecting on one's own feelings and thoughts. In this process, conceptual pairs of opposites, visualized in a measuring cylinder representation, are assessed using a 7-level rating scale, which, according to the literature, is best suited to represent affective relationships to experienced contacts with nature. Combined with the pre-post assessment of the Nature Connectedness Index (NCI; Richardson et al., 2019) to measure the degree of connection to nature, as well as open-ended items, the applicability and validity of the reflection tool will be further investigated in semi-structured, guideline-based interviews with learners. The pathway concept according to Lumber et al. (2017) provides the basis for offering nature experience activities to learners along the pathways (e.g. beauty, emotion and compassion). A pilot study investigates whether a free selection of individual pathway-based activities or completing a predetermined activity plan, each combined with the developed self-reflective exercises, has an effect on the perceived connection to nature of learners in the age cohort under consideration (e.g., grade 8, North Rhine-Westphalia). The former is expected. The main study plans to thoroughly test this assumption using a pre-post-follow-up test design.

Lowering barriers for student teachers to teach outdoors

Nienke Wieringa, Micha Ummels, Lidewij Van Katwijk and

Caspar Geraedts

| Poster |

Keywords: *Biology Teacher Education, Lowering Barriers For Outdoor Teaching, Fieldwork, Nature Awareness, Ecological Reasoning In Outdoor Settings*

Submission #: 254

Novice and preservice biology teachers frequently encounter significant barriers when organizing fieldwork, including limited species knowledge, concerns about classroom management, time constraints, and insufficient institutional support. To address these issues, Dutch academic teacher training programmes have, for three decades, organised an annual fieldwork week aimed at reducing such barriers and practicing the design and enactment of fieldwork lessons. The study we would like to present at the 2026 ERIDOB conference was conducted between 2022 and 2025 at one of our fieldwork week locations. It included 112 preservice biology teachers. The research questions are: (1) Which guiding principles do preservice teachers identify as most helpful for designing and implementing fieldwork lessons? and (2) How are these principles reflected in their lesson designs? The fieldwork week programme combined experiential learning—immersing participants in diverse fieldwork activities—with opportunities to design and teach their own lessons. Participants subsequently articulated guiding principles for effective and feasible fieldwork. The guiding principles were categorized as follows: (1) principles for designing fieldwork activities; (2) principles for instruction and guidance during the implementation of fieldwork activities; (3) principles for fostering student learning and nature awareness during fieldwork, and (4) principles for promoting ecological reasoning in real-world contexts. At ERIDOB, we will present these guiding principles alongside examples of their integration into lesson designs. Further research is required to assess the extent to which these principles become embedded in preservice teachers' professional practice and enable them to deliver authentic fieldwork experiences in schools.

Change in preservice science teachers' technology-related beliefs: the role of domain-specificity

Sarah Wilken and Benedikt Heuckmann

| Oral |

Keywords: *Change In Preservice Teachers' Beliefs, Technology Integration Into Human Biology Classes, Domain-Specific Beliefs, Teacher Training*

Submission #: 80

Preservice biology teachers' beliefs are crucial for learning about technology-enhanced teaching and for successful technology integration in biology teaching. As both technology integration and beliefs are shaped by the respective domain, it seems inconsistent that beliefs about technology integration are often examined without a domain context. Despite their importance, belief change during teacher education remains controversial, with recent studies indicating that it may depend on the domain. However, it remains unclear to what extent changes in preservice teachers' beliefs about technology integration depend on their domain-specificity. To address this issue, we assessed the beliefs of 308 preservice biology teachers differing in domain-specificity. We assessed non-domain-related beliefs (e.g., beliefs about technology-enhanced differentiation), domain-general beliefs (e.g., beliefs about enhancing motivation with technology in biology classes), and domain-specific beliefs (e.g., beliefs about technology-enhanced data acquisition, such as measuring pulse, in human biology classes). Changes were analyzed across two 12-week university courses focusing on technology-enhanced teaching and learning in human biology classes using linear mixed models. The results indicate that changes in beliefs varied by the degree of domain-specificity. Differences emerged not only in the magnitude of change but also in determining which components of the course (namely, theoretical input, practical experience, or reflection) were most influential. These findings suggest that changes in preservice teachers' beliefs during teacher education depend on both the course format and the domain-specificity of the content. In the context of technology integration within human biology courses, both theoretical instruction and practical application seem to contribute to shifts in beliefs.

Pre-service biology teachers' beliefs, emotions and intention to implement climate change education

Veronika Winter, Linda Hämmerle and Jelle Boeve-de Pauw

| Poster |

Keywords: *Climate Change Education, Pre-Service Teachers, Teacher Beliefs, Climate Emotions*

Submission #: 192

Biology teachers play a crucial role in preparing young people to navigate the challenges of the advancing climate crisis. Yet, climate change education (CCE) remains insufficiently embedded in teacher training, and teachers often face barriers such as limited curricular anchoring, lack of resources, and the scientific and emotional complexity of the topic. While growing research highlights how students' climate-related emotions shape their learning, the role of teachers' own climate emotions and their interplay with CCE beliefs and intentions to teach remains underexplored. This study addresses this gap by investigating how Austrian pre-service Biology teachers' CCE beliefs, climate emotions and teaching intentions are connected. The study applies a mixed-method design comprising a focus group discussion and a quantitative online survey. Tentative findings from the quantitative survey data (n = 107) indicate that CCE teaching intention is connected to believed importance of CCE and CCE self-efficacy beliefs. Further, pre-service biology teachers' climate anxiety and joy in climate action positively correlate with teaching intention, while climate hope and powerlessness showed no connection. This study contributes empirical insights into how teacher beliefs and climate emotions shape intentions to provide CCE, offering implications for designing teacher education that supports emotion-sensitive, action-oriented CCE.

Zoos as educational and conservation spaces: perspectives from (future) teachers

Raya L. Wolf, Paul W. Dierkes and Matthias W. Kleespies

| Poster |

Keywords: *Teacher Education, Conservation Education, Zoos, Extracurricular Learning, Perceptions*

Submission #: 198

Zoological gardens, which are popular destinations for school trips due to their important function as an extracurricular place of learning, also regard themselves as important institutions for environmental protection. However, only few studies examine teachers' attitudes towards environmental issues, though it is an important topic in education policy. There are only a limited number of studies that deal with teachers' attitudes towards the zoo. The aim of this study is to investigate how teachers and trainee teachers perceive the zoo as an extracurricular learning place. For this purpose, 126 teaching students and 303 teachers from Frankfurt participated in a paper or online survey. The survey covered three different topics: emotional attitude towards the zoo, perception of the zoo's tasks, and perception of the zoo as an extracurricular place of learning. Furthermore, participants were asked about their previous experiences at the zoo. The study examined differences between genders, different age groups, and different teaching professions. The results reveal no difference between the genders, but significant differences between age groups, with younger generations having more negative perceptions than older people. Additionally, teachers from primary schools have a more positive view of the zoo as an extracurricular learning place compared to those from high schools. It is therefore important to educate future teachers about the opportunities of zoos and the various ways in which they can be integrated into the classroom. To achieve this, zoos must establish additional points of contact, such as guided tours or specific teaching materials, particularly for secondary schools.

Valid assessment of the understanding of nature of science - a systematic literature review

Sarah Wünsche, Leroy Großmann, Daniela Mahler and Bianca Reinisch

| Oral |

Keywords: *Nature Of Science, Assessment, Systematic Literature Review, Validity, Biology*
Submission #: 79

Promoting the understanding of the Nature of Science (NOS) is a key objective of science education and a central element in fostering scientific literacy. NOS refers to the values, assumptions, and processes underlying the development of scientific knowledge. To effectively foster students' NOS understanding and diagnose its development, the valid assessment of NOS understanding is crucial for science education research. This systematic literature review aims to identify the reported evidence for the validity of established instruments and analyze how biology-specific NOS aspects are addressed. Therefore, the review analyzes the validity evidence reported in N = 33 studies that developed, validated, or applied established NOS assessment instruments. Instruments such as the Views of Nature of Science Questionnaire and the Student Understanding of Science and Scientific Inquiry Questionnaire primarily address general NOS aspects. Findings reveal that validity evidence based on test content was consistently addressed during instrument development, often through expert panels or literature-based item development. Evidence based on response processes was also commonly examined, whereas evidence based on internal structure and relations to other variables were less frequently tested. Evidence based on consequences of testing was not reported in any of the studies. The review highlights substantial variation in the validation of the interpretation of test results from NOS instruments and a persistent gap between the reported evidence and the intended interpretation/use arguments. Furthermore, none of the identified instruments explicitly considers biology-specific aspects of NOS, underscoring the need for a discipline-specific, theory-based instrument to assess biology-specific NOS understanding.

Designing inquiry-based teaching to enhance students' scientific creativity: a case study with a chinese biology teacher

Shiyu Xu, Michael Reiss and Wilton Lodge

| Oral |

Keywords: *Inquiry-Based Teaching, Scientific Creativity, Biology Teaching, Chinese Secondary School, Biology Classrooms*

Submission #: 26

Fostering students' scientific creativity is a key goal of biology education, with inquiry-based teaching seen as a promising approach. However, in China's examination-oriented educational system, implementing such pedagogy remains challenging. This study introduces an inquiry-based teaching project designed to enhance scientific creativity among upper secondary students in China. Using a case study design, the research involved one biology teacher and three grade-10 classes who collaboratively implemented 15 inquiry-based lessons over three months. Data were collected from lesson plans, slides, classroom videos, teacher interviews, and the researcher's diary, providing a comprehensive picture of the teaching and learning process. The project adopted a progressive inquiry-based approach, aligned with the teaching content, students' evolving inquiry skills, the teacher's belief in its value, and lesson duration and scheduling requirements. Four key teaching strategies were used for fostering scientific creativity, with high-achieving students and male students showing better adaptation to inquiry-based learning environment. The teacher observed significant changes in her students' biology learning, noted personal development in her teaching practice and relationships with students, and experienced growth in her creative traits. Despite challenges, including slower knowledge delivery that might impact students' performance on narrowly defined assessments and limited time for inquiry that caused schedule delays, the collaboration produced solutions to mitigate these issues. This study shows that well-adapted inquiry-based approaches can effectively foster students' scientific creativity in examination-oriented settings and offers insights for biology educators seeking to balance creativity development with academic demands.

Authentic biology education through citizen science: enhancing students' understanding of the nature of science

Leah Yifrach, Haya Ben Simon and Dina Tsybulsky

| Oral |

Keywords: *Authentic Learning, Nature Of Science, Citizen Science*

Submission #: 229

Authentic learning environments are increasingly recognized as essential for deepening students' engagement in scientific inquiry and for promoting informed understandings of the nature of science (NOS). Citizen science (CS) provides a particularly powerful context for authentic learning, as it enables learners to participate directly in ongoing scientific investigations and to engage with real data, methods, and research communities. Building on a three-dimensional model of authenticity, real-world, disciplinary, and personal, this study examines how a deliberately designed CS project supports secondary students' development of NOS understandings. The research involved 11 students (9th and 11th grade) who participated in "The Sleep Project," a two-phase CS learning sequence. In the first phase, students collected and analyzed two weeks of personal sleep data, explored group and national datasets using TinkerPlots, and generated research questions based on observed patterns. In the second phase, students conducted an experiment with Drosophila melanogaster using an infrared-based activity monitoring system to investigate ecological variation in sleep-related behaviors. The sequence integrated personal authenticity through student-selected questions, disciplinary authenticity through hands-on experimentation and data analysis, and real-world authenticity through work in a university laboratory and interaction with professional researchers. Data sources included recorded sessions, guided observations, students' work artifacts, and pre/post NOS questionnaires scored across five aspects. Qualitative analyses revealed meaningful engagement with key NOS aspects, particularly knowledge revision, scientific practices, and the role of theory. Quantitative results showed significant overall improvement in NOS conceptions (Wilcoxon $T=0$, $p<0.05$), with notable gains in four NOS aspects. Limited improvement was observed in understanding scientific collaboration. Findings demonstrate that intentionally embedding multiple dimensions of authenticity within CS can substantively enhance students' NOS understanding and support more sophisticated engagement with scientific inquiry.

Tell me more about plants!

Julia Zdunek and Jörg Zabel

| Oral |

Keywords: *Plant Awareness, Students' Conceptions, Conceptual Change, Narrative, Writing*

Submission #: 70

Plants are important stakeholders in ecosystems but often appear little interesting and hard to understand to learners. Hence, science education needs to identify teaching strategies that strengthen students' personal relationship to plants and that promote their biological understanding. Following insights of various disciplines, the production of narratives provides a promising tool to do both. By using a narrative approach in secondary classroom, this project aims to raise students' plant awareness. The established Conceptual Change theory is thereby extended by the idea of subjectivation - a individual change in the relation between the learner and the scientific content. To examine the narrative approach a one-day intervention was developed and set in a control group design. After a set of hands-on activities students are asked to produce and reflect on their self-written narratives (control group) or factual texts (control group) that explains one of the former presented concepts (sexual reproduction, defense of plants). A questionnaire, based on prior research aims to explore learners' conceptions and interest in plants. Qualitative content analysis will be used to compare students' narrative and factual texts. The pilot testing results (n=49) show significant changes in students' conceptions with a large effect size for both groups. Text products still reveal the unique potential of narratives for subjectivation and raise future questions.

Understanding interdisciplinary topics in science

Anna Zelená and Vanda Janštová

| Poster |

Keywords: *Content Analysis, Conceptual Framework, Integrated Education, Delphy Study*

Submission #: 42

Today's society faces global challenges such as global warming, the rise of lifestyle diseases, and issues of sustainability and human-induced environmental change. These issues transcend disciplinary boundaries and require a complex, interdisciplinary approach. Yet, lower secondary school students are mostly educated in a monodisciplinary way, and the previously mentioned phenomena are usually addressed from only one perspective. Integrating subjects through thematic units could provide a more comprehensive understanding. As shown by a Delphi study conducted as part of a Ph.D. project "Design of an Educational Programme for Teaching Integrated Science Education in Lower Secondary Schools" by Michal Blaško, experts agree that current and interdisciplinary topics should be included in science education. However, a unified content framework and teacher support are lacking. The topic "Current Natural Science and Ethical Challenges Affecting Human Health" is fragmented across materials, forcing teachers to develop their own resources. The project aims to develop for grade 9 a conceptual framework for this topic based on textbook and material analysis combined with Delphi study results.

ERIDOB 2026
15th Conference of European Researchers in Didactics of Biology
Ljubljana - Slovenia, August 24th-28th 2026.

Developing model-based teaching of the nervous system for pre-service teachers through design-based research

Li Zhuo, Maren Skjelstad Fredagsvik, Anne Berit Johnsen and

Pål Kvello

| Poster |

Keywords: *Nervous System Education, Model-Based Teaching, Design-Based Research, Conceptual Understanding, Learning Motivation*

Submission #: 234

Students often find the nervous system hard to learn and are not highly motivated to engage with it, partly because of its complexity and low accessibility. We developed a physical neuron model to help students learn the nervous system. To find proper ways of using the model, we designed an inquiry sequence based on the literature. Then we adopted design-based research (DBR) and ran four cycles with 39 second and third-year pre-service science teachers in Norway. Data collection includes pre-post concept tests, group interviews, and classroom video recording. After each cycle we analysed data then refined the design for the next cycle. The main outcome is a refined model-based teaching sequence that combines three short pre-class videos, a brief in-class lecture, and guided neural circuit-building activities using the neuron model, supported by diagrams. Students Concept understanding improved from pre- to post-test in each cycle. Motivation increased from Cycle 1 to Cycle 3 and dipped in Cycle 4. The study illustrates how DBR can be used to develop a model-based teaching sequences for improving students' understanding of the nervous system and motivation to learn about it.

Investigating teachers' professional development programs on climate change education

Inbal Ziv-Uziel, Nirit Lavie Alon and Tali Tal

| Poster |

Keywords: *Climate Change, Climate Change Education, Teachers' Professional Development, Content Knowledge, Pedagogical Content Knowledge*

Submission #: 49

Children and adolescents nowadays are growing into a world of climate uncertainty. They are facing the challenge of adapting to constantly changing climatic conditions, but furthermore, they hold the responsibility for handling the indefinite outcomes of climate change (CC). Education is critical for adaptation and mitigation of CC. The pedagogy and the content of education provide the knowledge and skills needed for making informed decisions in a changing environment. Teachers, holding a central role in CC education, must be well equipped with knowledge and practices for teaching this complex subject. Therefore, teachers' professional development (PD) programs are crucial for supporting teachers in the mission of CC education. Israel is pioneering a CC curriculum. Starting the school year of 2022-2023, the subject is mandatory for all K-12 students. To cope with the task, teachers' PD programs were designed and implemented. In this study we investigated the range of in-service middle and high school teachers' PD programs on CC education in Israel. The study highlights the characteristics and advantages of the different programs from the perspectives of both PD programs instructors and participants. Our findings indicate four main training models, all combining content knowledge with pedagogy, often including field trips. Teachers reported significant gains in knowledge, teaching skills, and confidence, supported by peer learning, expert lecturers, and experiential learning. Most teachers implemented the new knowledge in their classrooms. The study offers insights for improving future teacher's PD on CC and for strengthening the implementation of CC education in schools.