



ERIDOB 2022

13th CONFERENCE

OF EUROPEAN

RESEARCHERS

IN DIDACTICS

OF BIOLOGY

29TH AUGUST – 2ND SEPTEMBER 2022

NICOSIA - CYPRUS

Organized by: Department of Education

University of Cyprus

PROGRAMME AT A GLANCE

Time	Monday August 29 th	Tuesday August 30 th	Wednesday August 31 st	Thursday September 1 st	Friday September 2 nd
09:00-10:30	Registration Welcome Reception 18:30 -21:30	Registration 08:30 -... Opening Session 09:00-09:30	Paper Session 3A/3B/3C	Paper Session 5A/5B/5C	Keynote 2 9:00-10:00
10:30-11:00		Keynote 1 09:30-11:00	Coffee Break 10:30-11:00	Coffee Break 10:30-11:00	Coffee Break 10:00-10:30
11:00-12:30	Paper Sessions 1A/1B/1C 11:30-12:30	Paper Sessions 4A/4B/4C	Coffee Break 10:30-11:00	Paper Sessions 6A/6B/6C	Paper Sessions 8A/8B/8C 10:30-12:30
12:30-13:45	Lunch	Lunch	Lunch	Lunch	Closing Session 12:30-13:00 Lunch 13:00
13:45-15:30	Poster Sessions 1A/1B/1C	General Assembly/ Business Meeting	General Assembly/ Business Meeting	Poster Sessions 2A/2B	End of conference
15:30-16:00	Coffee Break	Coffee Break	Coffee Break	Coffee Break	
16:00-17:30	Paper Sessions 2A/2B/2C	Tours 16:00 -...	Tours 16:00 -...	Paper Sessions 7A/7B/7C	
18:30 - ...	Researcher café and more 17:30-18:30 ECR Party 20:00-...	Researcher café and more 17:30-18:30 ECR Party 20:00-...	Conference Dinner 19:30 -...	Conference Dinner 19:30 -...	

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ACADEMIC COMMITTEE

- **Dr Orit Ben Zvi Assaraf**, Ben-Gurion University of the Negev, Israel
 - **Dr Niklas Gericke**, Karlstad University, Sweden
 - **Dr Marcus Grace**, Southampton University, UK (Chair)
 - **Dr Marie-Christine Knippels**, University of Utrecht, Netherlands
 - **Dr Konstantinos Korfiatis**, University of Cyprus, Cyprus
 - **Dr Olivier Morin**, University of Lyon, France
 - **Dr Blanca Puig**, University of Santiago de Compostela, Spain
 - **Dr Jörg Zabel**, Leipzig University, Germany
-

LOCAL ORGANIZING COMMITTEE

- **Dr Konstantinos Korfiatis**
- **Dr Zacharias Zacharia**
- **Dr Stella Petrou**
- **Rafaella Mallouppa**
- **Vasiliki Vasileiou**
- **Anthi Christodoulou**

FOREWORD

The ERIDOB Academic Committee has invited researchers in Biology Didactics to take part in the XIIIth Conference of European Researchers in Didactics of Biology. The conference is held at the University of Cyprus, from the 29th of August- to the 2nd of September 2022.

More information about the conference can be found on the conference webpage: <https://2022.eridob.org/>

The aim of the conference is to give researchers in Biology Didactics the opportunity to present and discuss their research and results. Contributions should fit into one of the following strands within biology education:

- Students' conceptions and conceptual change
- Students' interest and motivation
- Students' values, attitudes and decision-making
- Scientific thinking, nature of science and argumentation
- Teaching strategies and learning environments
- Teaching and learning with educational technology
- Outdoor and environmental education
- Health education
- Social, cultural, and gender issues
- Language and Biology Education

PREVIOUS ERIDOB CONFERENCES

Zaragoza, Spain 2018

Karlstad, Sweden 2016

Haifa, Israel 2014

Berlin, Germany 2012

Braga, Portugal 2010

Utrecht, Netherlands 2008

London, UK 2006

Patra, Greece 2004

Toulouse, France 2002

Santiago de Compostela, Spain 2000

Goteborg, Sweden 1998

Kiel, Germany 1996

FUNDING AND SPONSORS



REPUBLIC OF CYPRUS
DEPUTY MINISTRY OF TOURISM



The Unit for Education
for the Environment and
Sustainable Development
(EESD)



Pancyprian Gymnasium

KORRES

Welcome to ERIDOB 2022 in Nicosia!

Dear Colleagues,

We are delighted to welcome you to the University of Cyprus and the XIIIth conference of European Researchers in Didactics of Biology (ERIDOB).

ERIDOB has met every two years since 1996. However, the pandemic didn't allow us to organise the conference in 2020. Now, we are thrilled to meet each other in-person again, after four years, in the only European conference dedicated exclusively to biology education research.

The XIIIth ERIDOB conference hosts more than 180 participants from all over Europe, as well as other countries such as USA and South Africa. We hope that the conference will retain the famous ERIDOB friendly, supportive and cosy spirit which facilitates a joyful atmosphere and productive interactions between new and experienced researchers alike.

The XIIIth ERIDOB conference incorporates a "French aspect": some papers will be presented by French colleagues in French with English slides. The French aspect is also celebrated through the first keynote talk by two French colleagues: Catherine Bruguière and Denise Orange Ravachol. They will talk about "problematization, narrative and fiction in science classrooms". The second keynote talk by Zacharia Zacharia will focus on the hot topic of STEAM education and especially on "Using Physical and Virtual labs for Experimentation in STE(A)M Education: From Theory and Research to Practice."

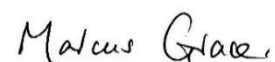
The social programme of the conference (including the welcome reception, the Early Career Researchers' party, the conference dinner, as well as excursions and tours) offers opportunities for informal meetings and discussions, as well as for visiting some interesting natural and cultural sites of the island. In addition to the above, the 'Researchers' Café', i.e. an open session where an individual or a group of researchers can present projects or relevant information to the ERIDOB community, aims to further encourage informal communication and fruitful exchanges of ideas.

We would like to acknowledge the substantial work of the Academic Committee for reviewing and planning the conference. Additionally, the Academic Committee would like to thank all the reviewers for their substantial work. We would also like to thank the funders and sponsors of this conference, and especially the University of Cyprus, and the Deputy Ministry of Tourism. Finally, we would like to express our gratitude to the Local Organizing Committee for their hard work and commitment for the many months leading up to the conference itself.

We hope you will enjoy the conference and your stay in Nicosia.



Konstantinos Korfiatis
Chair of the Local
Organizing Committee



Marcus Grace
Chair of the Academic
Committee of ERIDOB

KEYNOTES

Title: Problematization, narrative and fiction in science classroom

Presenters: Dr. Catherine Bruguière & Dr. Denise Orange Ravachol



Catherine Bruguière is a researcher in didactics of biology in the laboratory Sciences Society Historicity Education and Practices (S2HEP <https://s2hep.univ-lyon1.fr/>) at the University of Lyon 1 (France). Since 1 January 2021, she is the director of this multidisciplinary laboratory of didactics, history and philosophy of science, technology and health. Her work is part of a didactic approach with a strong epistemological basis. For the past fifteen years, she has been conducting collaborative research with primary school teachers, focusing on the functions of narrative and fiction in scientific learning. Her objects of study are children's storybooks and novels. In 2014, she was awarded a Marie Skłodowska-Curie European grant for the project "Associating Literature and the Imaginary with Science: Early Years Education" (ALIS), conducted at the University College of London (2016-2017) with Sue-Dale Tunnicliffe as Supervisor. Since 2020, she is vice-president of the Association for Research in Didactics of Science and Technology (ARDIST, <https://ardist.org/>). <https://s2hep.univ-lyon1.fr/catherine-bruguiere>



Denise Orange Ravachol is Professor Emeritus at the University of Lille (CIREL Research Laboratory). She holds a degree in natural sciences from the Ecole Normale Supérieure (Paris). She has taught in secondary schools, in teacher training programs and at university. Her research, with a strong epistemological orientation, focuses on functionalist and historical problematizations in biology and geology education, and on "Educational approaches" (to sustainable development, to health). She also explores the conditions under which students can take on the process of problematization as a means to conceptualize the past and the future of living beings and the Earth.

Title: Using Physical and Virtual labs for Experimentation in STE(A)M Education: From Theory and Research to Practice.

Presenter: Dr. Zacharias C. Zacharia



Zacharias C. Zacharia is a Professor of Science Education and director of the Research in Science and Technology Education Group at the University of Cyprus. He completed a B.A. in Education at the University of Cyprus (Cyprus), a B.A. in Physics at Rutgers University – New Brunswick (USA), and his graduate studies (M.A., M.Sc., M.Phil and PhD) in Science Education at Columbia University, New York (USA). He was the (co-) coordinator of several research projects concerning computer supported, inquiry-based learning that received continuous financial support over the years from the Cyprus Research Promotion Foundation and the European Commission. His

research interests include among others the design and development of computer supported learning environments in science and STE(A)M education, the development and assessment of science and STE(A)M curriculum and learning materials, and the training of teachers for designing and implementing technology enhanced science teaching materials. Zacharias Zacharia has received several awards in recognition of outstanding scholastic achievement and excellence, and has published many papers in major ISI journals (e.g., Science, Cognition and Instruction, Learning and Instruction, Journal of Research in Science Teaching). He was an associate editor for the past six years for the Journal of Research in Science Teaching and currently an editor for the Eurasia Journal of Mathematics, Science and Technology Education, and a member of the editorial board of the Journal of Science Education and Technology and the Journal of Computers in Mathematics and Science Teaching. He is also a reviewer for several major ISI journals. <https://www.ucy.ac.cy/resciteg/en/>

REVIEWERS

All the submitted proposals for the conference have been anonymously reviewed by at least two senior researchers. Here follows the list of the reviewers of the conference.

Alexander Bergmann	Germany
Alexander Büssing	Germany
Alexandra Moormann	Germany
Alexandra Sá-Pinto	Portugal
Amu Castera	France
Ana Valdmann	Estonia
Andreani Baytelman	Cyprus
Andreas Hadjichambis	Cyprus
Andrej Šorgo	Slovenia
Anna Beniermann	Germany
Anna Marbà	Spain
Anna-Lena Stettner	Germany
Annette Upmeier Zu Belzen	Germany
Araitz Uskola	Spain
Armin Lude	Germany
Asimakis Talamagas	Greece
Athanasios Mogias	Greece
Bento Cavadas	Portugal
Birgitta Mc Ewen	Sweden
Britta Bueker	Germany
Carolin Retzlaff-Fürst	Germany
Catherine Bruguere	France
Catie Nielson	United States
Christina Ottander	Sweden
Clas Olander	Sweden
Daniel Olsson	Sweden
Daniela Fiedler	Germany
Daniela Mahler	Germany
Demetra Hadjichambi	Cyprus
Denise Bock	Germany
Denise Orange	France
Dina Tsybulsky	Israel
Dirk Krüger	Germany
Eija Yli-Panula	Filand
Eliza Rybska	Poland
Evangelia Mavrikaki	Greece
Francois Lombard	Switzerland
Frederic Charles	France
Gabriel Enrique Ayuso Fernández	Spain
Georgios Ampatzidis	Greece
Graça S. Carvalho	Poland
Gregor Torkar	Slovenia
Gunnar Höst	Sweden
Gur Arie Livni Alcasid	Israel

Idit Adler	Israel
Isabel Banos-González	Spain
James Williams	UK
Jan Cincera	Czech Republic
Jana Nolding	Germany
Jelle Boeve-De Pauw	Netherlands
Joserra Díez	Spain
Julia Lorke	Germany
Julia Zdunek	Germany
Justin Dillon	UK
Kathrin Ziepprecht	Germany
Katrin Vaino	Estonia
Kerstin Röllke	Germany
Konrad Schönborn	Sweden
Laura Colucci-Gray	UK
Leroy Großmann	Germany
Lhoste Yann	Belgium
Lissy Jäkel	Germany
Liz Lakin	United Kingdom
Lucía Vázquez-Ben	Spain
Magali Coupaud	France
Magali Fuchs Gallezot	France
Marcus Hammann	Germany
Margarida Morais Marques	Portugal
María Napal Fraile	Spain
Marianna Kalaitzidaki	Greece
Marida Ergazaki	Greece
Mark Winterbottom	UK
Martha Georgiou	Greece
Martin Scheuch	Austria
Mats Lundström	Sweden
Matthias Wilde	Germany
Melanie Schaller	Germany
Melissa Glackin	UK
Merav Siani	Israel
Mercedes Jaen	Estonia
Micha Ummels	Netherlands
Michael Ewig	Germany
Michael Reiss	UK
Michal Haskel-Ittah	Israel
Michal Zion	Israel
Michiel Dam	Netherlands
Michiel van Harskamp	Netherlands
Moriah Ariely	Israel
Moritz Krell	Germany
Nina Christenson	Sweden
Nina Minkley	Germany
Nirit Lavie Alon	Israel

Oier Pedrera	Spain
Pablo Brocos	Spain
Paloma Blanco Anaya	Spain
Panagiotis Stasinakis	Greece
Patricia Schneeberger	France
Penelope Papadopoulou	Greece
Peter Lampert	Sweden
Ragnhild Lyngved Staberg	Norwegian
Ralph Levinson	UK
Reuven Babai	Israel
Sabine Meister	Germany
Sandie Bernard	France
Shanny Mishal	Israel
Sonia Felix	Norwegian
Stephen Price	UK
Sue Dale Tunnicliffe	UK
Susan Pollin	Germany
Tassos Mikropoulos	Greece
Tetiana Krushynska	Ukraine
Tim Hartelt	Germany
Tuomas Aivelo	Finland
Ute Harms	Germany
Vida Lang	Slovenia
Yael Shtechman	Israel
Zélia Anastácio	Portugal

INSTRUCTIONS FOR PRESENTATIONS

Single Oral Presentations

The oral presentations should be maximum **15 minutes** long, followed by **5 minutes** for questions and/or discussion. Computers and projectors will be available in all conference rooms. We recommend that you bring your presentation on a memory stick and upload it before the session starts.

* Presentations in the French language should prepare the slides in English.

Symposia

Symposia follow the same procedure as oral presentations. Note that the number of participants might differ between symposia and there might be more time available for discussion at some symposia. The chair of the symposia is responsible for the timing of the presentations, and if there should be a longer summarizing discussion after all presentations are completed or a short discussion after each paper.

Posters and Interactive Poster Presentations

Posters should be printed on paper in portrait format and should not exceed 84 cm in width and 118 cm in height (A0 poster will fit perfectly). Materials for placing posters on boards will be available in the Poster areas.

Before the traditional walkaround poster presentation, you will be asked to present your poster in 3 minutes (maximum) for the audience as a whole. There is the opportunity to present the poster with the aid of PowerPoint slides (a maximum of two slides). The slides are optional.

Session's Chair

The chair is responsible for that the session starts on time and that all presentations are given equal time frames.

In the case of a smaller or bigger than the average number of presentations in a session, the time for discussion is modified accordingly, but the time for presentations remains unchanged.

The chair takes responsibility for these possible accommodations.

CONFERENCE BOOK

ERIDOB will publish an edited volume with selected papers that have been presented at the 13th ERIDOB Conference.

The book will be published by Springer, within the *ERIDOB Book Series: Contributions from Biology Education Research* (<https://www.springer.com/series/16350>).

You are invited to submit your full paper based on your conference presentation until **November 30th, 2022**.

Please note that:

- This invitation only applies to colleagues whose papers (oral or poster) have been presented at the 13th ERIDOB Conference in Cyprus.
- Submitted papers will go through a peer review process before being accepted for publication.
- Only completed research with fully-analysed data will be considered for publication.
- You will be informed about the style, format and submission procedure of the manuscripts in due time. Please keep in mind that, in any case, the final paper should not exceed the **limit of 5000 words** (including references, abstracts, tables and figures).

PROGRAMME

DETAILED PROGRAMME

Time	Monday, August 29 th
18:30-21:30	Registration
	Welcome Reception - Social Event
Location:	Museums of the Pancyprian Gymnasium
Time	Tuesday, August 30 th
08:30	Registration
Location:	University of Cyprus
09:00-09:30	Opening Session
Location:	Building: ΧΩΔ02, Room: B205
	Welcome and Opening Speech by the Rector of the University of Cyprus, Tasos Christofides
09:30-11:00	Keynote 1
Title:	Problematization, narrative and fiction in science classroom
Speakers:	Catherine Bruguière and Denise Orange Ravachol
Location:	Building: ΧΩΔ02, Room: B205
Chair:	Jörg Zabel
11:00-11:30	Coffee Break
Location:	1 st floor balcony
11:30-12:30	Parallel Paper Session 1
	Paper Session 1A - Teaching and Learning with Educational Technology
Location:	Building: ΧΩΔ01, Room: 109
Chair:	Anat Yarden
Title:	Perspectives on Social Media Use in Biology Education – A Qualitative Study with German Pre-Service Biology Teachers
Author(s)	Alexander Bergmann, Anna Beniermann and Alexander Büssing
Title:	An intervention to encourage plant appreciation in Life Sciences teachers - a case study
Author(s)	Benjamin A. Coetzer and Amelia L. Abrie
Title:	Characterizing Ecology and Evolution ELearning Units Designed by Biology Teachers
Author(s)	Merav Siani, Carmel Bar and Anat Yarden
	Paper Session 1B - Outdoor and Environmental Education
Location:	Building: ΧΩΔ01, Room: 108
Chair:	Marie-Christine Knippels
Title:	Teachers' self-efficacy and practices in ESD: A longitudinal study on the impact of professional development
Author(s)	Jelle Boeve-de Pauw, Daniel Olsson, Teresa Berglund and Niklas Gericke
Title:	The secondary school teachers' conceptualizations of the education for sustainable development and it's dimensions
Author(s)	Rolf Saarna and Anne Laius
Title:	Fostering Environmental Citizenship competences through Socio-Scientific Inquiry-Based Learning
Author(s)	Michiel van Harskamp, Marie-Christine Knippels and Wouter R van Joolingen

	Paper Session 1C - Teaching Strategies and Learning Environments
Location:	Building: XΩΔ01, Room: 103
Chair:	Tali Tal
Title:	The contribution of citizen science in an outdoor environment to improving achievements and attitudes towards science of students from low socio-economic status.
Author(s)	Lavi Oren, Nirit Lavie Alon and Tali Tal
Title:	Subject student teachers' views on key environmental problems and their role as a solver of these problems
Author(s)	Eija Yli-Panula and Eila Jeronen
Title:	Scientific inquiry in mentor teacher training: a study about a biology-related mentor training and the impact on practical experience settings
Author(s)	Emanuel Nestler and Carolin Retzlaff-Fürst
12:30-13:45	Lunch
Location:	Restaurant A.Zorbas
13:45-15:30	Parallel Poster Session 1
	Poster Session 1A - Outdoor and Environmental Education
Location:	Building: XΩΔ01, Room: 104
Chair:	Gregor Torkar
Title:	Partnerships for Science Education: public health education and awareness with digital technologies
Author(s)	Dimitris Chalkidis, Carolina Santos and Tassos A. Mikropoulos
Title:	Nature play as a way of learning biology in early years
Author(s)	Marjanca Kos, Martina Mohorič, Luka Praprotnik, Sue Dale Tunnicliffe and Gregor Torkar
Title:	Mapping adolescents' nutritional knowledge
Author(s)	Matina Moshogianni and Martha Georgiou
Title:	Inter-sectorial partnerships in implementing climate change education in the Israeli school system
Author(s)	Nofar Naugauker, Orit Ben Zvi Assaraf, Daphne Goldman and Efrat Eilam
Title:	Unveiling the more salient components of Education for Environmental Citizenship in environmental Citizen Science initiatives: A systematic literature review of empirical research
Author(s)	Anastasia Adamou, Yiannis Georgiou, Demetra Hadjichambi and Andreas Hadjichambis Ch.
Title:	Symbolic experiences of nature on near-natural schoolgrounds
Author(s)	Anna-Lena Stettner and Armin Lude
Title:	How inclusive are the Environmental Education Centers in Greece
Author(s)	Rodanthi Lyraki and Marianna Kalaitzidaki
Title:	Teachers' experiences in a pilot project based on schoolyard biodiversity
Author(s)	Arnau Amat, Isabel Jiménez Bargalló, Chadia Rammou and Jordi Martí

Title:	Good ways to teach species knowledge of plants...
Author(s)	Martin Feike, Susan Pollin and Carolin Retzlaff-Fürst
	Poster Session 1B - Teaching Strategies and Learning Environments
Location:	Building: XΩΔ01, Room: 103
Chair:	Graça S. Carvalho
Title:	Diagnosing of valuing and decision-making competences in biology lessons
Author(s)	Malte Ternieten and Doris Elster
Title:	An app for teaching basic chemistry to biologists: spatial ability, prior knowledge, cognitive load and usability
Author(s)	Stefan Witzke and Claudia Nerdel
Title:	Learning trajectories in evolution education: analysing digital concept mapping using methods of learning analytics
Author(s)	Berit Katharina Czinczel, Daniela Fiedler and Ute Harms
Title:	Learning communities for the professional development of digital teaching
Author(s)	Melanie Ripsam and Claudia Nerdel
Title: 103	An Investigation of Pre-Service Biology Teachers' Enacted TPACK.
Author(s)	Alexander Aumann and Holger Weitzel
Title:	The shell model as a planning model for distance teaching
Author(s)	Annemarie Rutkowski, Christian Förtsch, Dagmar Traub, Monika Aufleger and Birgit Jana Neuhaus
Title:	Pre-service Teachers' Behavioral and Control Beliefs on the Subject-specific Use of Digital Media in Biology Classrooms
Author(s)	Maja Funke and Jörg Zabel
Title:	Reflections of prospective biology teachers on the construction and use of smartphones as microscopes in biology classes
Author(s)	Vida Lang and Andrej Šorgo
Title:	Teacher's perceptions of objectifying explanatory black-boxes in the biology classroom
Author(s)	Gur Arie Livni Alcasid and Michal Haskel-Ittah
Title:	Elaboration and validation of experimental activities on fermentation/respiration using easily-accessible materials to be implemented in Mozambique
Author(s)	Graça S. Carvalho, Manecas Azevedo and Paulo Mafra
	Poster Session 1C - Students' Conceptions and Conceptual Change
Location:	Building: XΩΔ01, Room: 102
Chair:	Michal Haskel-Ittah
Title:	Analysis of Covid19-related biological mechanistic information presented in the media
Author(s)	Shanny Mishal and Michal Haskel-Ittah
Title:	Students' conceptual understanding of core ideas in biology
Author(s)	Helin Semilariski and Anne Laius
Title:	Primary student's ideas about biodiversity contents in a biodiver project

Author(s)	Chadia Rammou, Arnau Amat, Isabel Jiménez Bargalló and Jordi Martí
Title:	Urban and rural children's perceptions of farm animals and pets
Author(s)	Eliza Rybska, Paulina Smoła and Costas Constantinou
Title:	Where do plants get their mass from? Using drawings to assess secondary students' modelling skills and their ideas about plant growth
Author(s)	Zofia Chyleńska, Eliza Rybska, Joanna Wojtkowiak, Pantelitsa Karnaou and Costas P. Constantinou
Title:	Evolution Education: Difficulties in Population Thinking and how it develops in Upper Secondary School
Author(s)	Martin Scheuch, Gerald Fuchs, Christine Heidinger and Heidemarie Amon
Title:	Primary school pupils facing a eutrophication problem: causes, consequences and solutions
Author(s)	Mercedes Jaén García, Isabel Banos-González, Patricia Esteve-Guirao and Magdalena Valverde Pérez
Title:	Conceptions of students and teachers about the biological impact of climate change
Author(s)	Britta Bueker and Dominik Begerow
Title:	Combining behavioral and neuroimaging research on university student error detection in biological models
Author(s)	Joe Dauer, Mei Grace Behrendt, McKenna Elliott and Caron A.C. Clark
15:30-16:00	Coffee Break
Location:	1 st floor balcony
16:00-17:30	Parallel Paper Session 2
	Paper Session 2A - Language and Biology Education
Location:	Building: XΩΔ01, Room: 109
Chair:	Michael Ewig
Title:	Narrative Explanations and Temporality of Natural Selection: A Case study in a French Grammar School
Author(s)	Fabienne Paulin, Catherine Bruguière and Jörg Zabel
Title:	Reading a fictional storybook in a primary biology lesson: questioning the reasons of development of life on Earth
Author(s)	Frederic Charles
Title:	Plain Language Texts in Biology Classes for Fifth-Graders – Influences on the Declarative Knowledge and Attitudes towards them
Author(s)	Melanie Schaller and Michael Ewig
Title:	Piloting the students' learning activity: the didactic language gestures of the biology teacher
Author(s)	Lhoste Yann
	Paper Session 2B - Teaching Strategies and Learning Environments
Location:	Building: XΩΔ01, Room: 103
Chair:	Lars Meyer-Odewald

Title:	Competence Matrices in Biology Education – An Instrument to Encourage the Basic Needs Fulfilment of all Students in Heterogeneous Learning Groups?
Author(s)	Marlen Grimm and Carolin Retzlaff-Fürst
Title:	Comparing experimental protocols as method of teacher education in the context of scientific inquiry
Author(s)	Lars Meyer-Odewald, Kathrin Ziepprecht and Rita Wodzinski
Title:	Future-oriented Pedagogy for Molecular Biology Inquiry-based Learning in High School Biology Laboratories
Author(s)	Dana Sachyani, Pirchia Tamar Waxman, Irit Sadeh, Shoshana Herman, Mor Levi Ferber, Michal Yacobi, Omer Choresch, Efrat Link, Shiri-Rivka Masa, Samuel Ginsburgand and Michal Zion.
Title:	Elementary school students' evaluation of explanations to biological phenomena
Author(s)	Yael Shtechman, Marida Ergazaki and Michal Haskel-Ittah
	Paper Session 2C - Teaching Strategies and Learning Environments
Location:	Building: XΩΔ01, Room: 108
Chair:	Michael Reiss
Title:	Investigative school research projects in biology: Effects on students
Author(s)	Wilton Lodge, Michael Reiss and Richard Sheldrake
Title:	Concept mapping as an adequate retrieval-based learning opportunity in biology
Author(s)	Sina Lenski, Mirlinda Mustafa and Jörg Großschedl
Title:	The effects of a peer tutorial with an integrated learning strategy training on the biology students' use of learning strategies in university
Author(s)	Matthias Wilde and Svea Kleinert
Title:	Validation of a scoring rubric to measure pre-service biology teachers' lesson plan quality
Author(s)	Leroy Großmann and Dirk Krüger
17:30-18:30	Research Café* & More**
Location:	Building: XΩΔ01, Room: 103
	*An open space where an individual or group of researchers can present projects or relevant information for the ERIDOB community. Please let the Local Committee know in advance if you wish to present something. **More rooms will be available to use if you wish to discuss any other subject.
20:00	ECR Party-Social Event
Location:	The Old Power House
Time	Wednesday, August 31st
09:00-10:30	Parallel Session 3
	Paper Session 3A - Outdoor and Environmental Education
Location:	Building: XΩΔ01, Room: 108
Chair:	Marcus Hammann
Title:	I want to engage my pupils in climate change, but...
Author(s)	Mikael Rydin, Niklas Gericke, Jesper Haglund and Nina Christenson
Title:	Personal relevance in high school students' nature experiences: Findings from the draw-and-write method

Author(s)	Marcus Hammann
Title:	Action Competence for Insect Preservation (ACIP) – A new framework and quantitative scale to take action for insects
Author(s)	Peter Lampert, Daniel Olsson and Niklas Gericke
Title:	An Action Research Approach for the development of children’s environmental motivation through their participation in a schoolgarden project: Reflections and Revisions
Author(s)	Anthi Christodoulou and Konstantinos Korfiatis
	Paper Session 3B - Scientific Thinking, Nature of Science and Argumentation
Location:	Building: XΩΔ01, Room: 103
Chair:	Dina Tsybulsky
Title:	Pre-service biology teachers' socioscientific decision-making: Analyzing structural and content complexity in the context of a mandatory Covid-19 vaccination
Author(s)	Nina Minkley, Carola Garrecht and Moritz Krell
Title:	Enlightening Our Visitors: Natural History Museum Educators’ Conceptualize the Integration of NOS When Addressing Ecological and Evolutionary Aspects of Exhibits
Author(s)	Anna Pshenichny-Mamo and Dina Tsybulsky
Title:	The Role of Biological Content-Knowledge for Abductive Reasoning in Modeling
Author(s)	Paul Engelschalt, Dirk Krüger and Annette Upmeier zu Belzen
Title:	Effects of (non-)restrictive learning opportunities on the development of research competence in biology education
Author(s)	Lea Gussen, Fabian Schumacher, Laura Ferreira González, Kirsten Schlüter and Jörg Großschedl
	Paper Session 3C - Teaching Strategies and Learning Environments
Location:	Building: XΩΔ01, Room: 109
Chair:	Christina Ottander
Title:	Promoting digitally supported experimentation in heterogeneous classes through teacher training
Author(s)	Patrizia Weidenhiller, Susanne Miesera and Claudia Nerdel
Title:	The influence of International collaboration on open inquiry-based teaching - A case study
Author(s)	Pirchia Tamar Waxman, Christine Girtain, Dana Sachyani, Galit Karadi, Irit Sadeh, Shoshana Herman, Mor Farber Levi, Michal Yaacobi, Omer Choshesh, Efrat Link, Samuel Ginsburgand and Michal Zion
Title:	Using educational technologies to characterize students’ explanation types as means to promote personalized teaching and learning
Author(s)	Moriah Ariely, Tanya Nazaretsky and Giora Alexandron
Title:	Digital science competence: Secondary school students’ reasoning about filter bubbles and search engines
Author(s)	Anna Lodén, Johanna Lönnngren and Christina Ottander
10:30-11:00	Coffee Break
Location:	1 st floor balcony

11:00-12:30	Parallel Session 4
	Paper Session 4A - Students' Conceptions & Conceptual Change
	Symposium 1: Evolution education research across the educational stages: Obstacles and opportunities for teaching and learning evolution
Location:	Building: XΩΔ01, Room: 108
Chair:	Daniela Fiedler
Title:	What about the children? Developing an instrument to measure knowledge about evolution in kindergarten
Author(s)	Isabell K. Adler, Daniela Fiedler and Ute Harms
Title:	Comparing elementary school students' predictions and explanations of evolutionary processes- an exploratory study within the EuroCitizen network
Author(s)	Lucía Vázquez Ben, Patrícia Pessoa, Neil J. Gostling, Nausica Kapsala, Alexandra Moormann, Giulia Realdon, Mónica Arias, Alessandra Beccaceci, Livia Bianchet, Giulia Bombi, Moraima Castro-Faix, Margarida M. Marques, María del Carmen Souto García and Xana Sá-Pinto
Title:	Is this about me? Understanding the impact of anthropocentrism on undergraduate learning about antibiotic resistance
Author(s)	Catie Nielson and John D. Coley
Title:	Diagnosing evolutionary explanations: Effects of a chatbot support system on teacher students' diagnostic competence
Author(s)	Daniela Fiedler, Daniel Schönle, Christoph Reich and Ute Harms
	Paper Session 4B - Students' Values, Attitudes and Decision Making
Location:	Building: XΩΔ01, Room: 109
Chair:	Anna Beniermann
Title:	Aquaculture - how pre-service teachers' perception interacts with environmental values, system knowledge and conceptions of environmental concern for decision
Author(s)	Michaela Maurer, Verena Pietzner and Corinna Hößle
Title:	Attitudes towards Controversial Science Issues and their justifications in pre-service biology teachers
Author(s)	Anna Beniermann, Sascha Kurz and Annette Upmeier zu Belzen
Title:	Do Biology Textbooks Help Teachers in Dealing with Socio-scientific Issues? - A Content Analysis of German Biology Textbooks
Author(s)	René Leubecher, Alexander Bergmann, Maja Funke and Jörg Zabel
Title:	Factors that influence elementary school students' attitudes towards intraspecific biodiversity
Author(s)	Patrícia Pessoa, Sara Aboim, Lisa Afonso, J. Bernardino Lopes and Xana Sá-Pinto
	Paper Session 4C - Outdoor & Environmental Education
	Symposium 2: Environmental Literacy – Appropriate Umbrella for Educational Initiatives
Location:	Building: XΩΔ01, Room: 103
Chair:	Bogner F.X.

Title:	Environmental Attitude's Pivotal Role for Learning
Author(s)	Baierl, T., Kaiser F. X., and Bogner F.X.
Title:	Informal Earth Education: Significant Shifts for Environmental Attitude and Knowledge
Author(s)	Baierl, T., Johnson, B. and Bogner F.X.
Title:	The Impact of Environmental and Sustainability Education on Environmental Literacy of Secondary School Students
Author(s)	Cincera, J., Kroufek, R. and Bogner, F.
12:30-13:45	Lunch
Location:	Restaurant A.Zorbas
13:45-15:30	General Assembly / Business Meeting
Location:	Building: XΩΔ02, Room: B205
16:00	Tours - Social programme
Time	Thursday, September 1st
09:00-10:30	Parallel Paper Session 5
	Paper Session 5A - Outdoor and Environmental Education
Location:	Building: XΩΔ01, Room: 103
Chair:	Annette Scheersoi
Title:	The impact of animal encounters on zoo visitors' interest in conservation
Author(s)	Jana Schilbert and Annette Scheersoi
Title:	"Environmental citizens in Action": A novel learning intervention grounded on the Education for Environmental Citizenship pedagogical approach
Author(s)	Andreas Ch. Hadjichambis, Demetra Hadjichambi and Yiannis Georgiou
Title:	Measuring psychological distance towards climate change: A new multidimensional scale and its correlates
Author(s)	Alexander Büssing
Title:	Gaining Insights into Biologists' Work Locations and Scientific Activities
Author(s)	Bianca Reinisch, Daniela Mahler, Jasmin Opitz, Moritz Krell and Tom Bielik
	Paper Session 5B - Scientific Thinking, Nature of Science and Argumentation
Location:	Building: XΩΔ01, Room: 108
Chair:	Marcus Grace
Title:	Arguments from Vaccine Hesitancy about COVID-19 in Spain: Epistemic disagreements
Author(s)	María Pilar Jimenez Aleixandre
Title:	Questioning Mandatory Vaccination: A Way To Grasp The Concept Of Herd Immunity?
Author(s)	Olivier Morin and David Favre
Title:	In what ways does the pandemic influenced teaching and interest for contagious - Swedish middle school pupils' reflections in the backdrop of Covid-19?
Author(s)	Anna-Clara Rönner, Anna Jakobsson and Niklas Gericke

Title:	Science teachers' views on how to approach scientific misinformation in schools.
Author(s)	Marcus Grace and Keith Smith
	Paper Session 5C - Scientific Thinking, Nature of Science and Argumentation
Location:	Building: XΩΔ01, Room: 109
Chair:	Andreani Baytelman
Title:	Dialogue between evolution and belief in the Israeli diverse education system: Biology education experts' views
Author(s)	Netta Dagan, Tali Tal and Masha Tsaushu
Title:	Natural History Museum Visitors' Evolution Acceptance
Author(s)	Alexandra Moormann, Anna Beniermann and Daniela Fiedler
Title:	Students' (12-13 years old) ideas about chance and evolution during the game Darwinium during a playful activity
Author(s)	Magali Coupaud, Jérémy Castéra, Miguel Rotenberg, Eric Tortochot, Corinne Jégou, Hélène Cheneval-Armand, Sabrina Marchi, Pascale Brandt-Pomares, Claire Coiffard-Marre and Alice Delserieys Pedregosa
Title:	Investigating relationships between epistemological beliefs and personal beliefs in biological evolution
Author(s)	Andreani Baytelman, Theonitsa Loizou and Salomi Hadjiconstantinou
10:30-11:00	Coffee Break
Location:	1 st floor balcony
11:00-12:30	Parallel Paper Session 6
	Paper Session 6A - Students' Values, Attitudes and Decision Making
Location:	Building: XΩΔ01, Room: 103
Chair:	Marcus Hammann
Title:	Secondary school students facing fashion consumption and disposal
Author(s)	Isabel Banos-González, Patricia Esteve Guirao, Mercedes Jaén and Maria Ángeles García Fortes
Title:	Factors influencing the intention of students in regard to stem cell donation for leukaemia patients - a comparison of non-intenders and intenders
Author(s)	Julia Holzer and Doris Elster
Title:	Learning about intraspecific biodiversity conservation with "Jack and the Beanstalk"
Author(s)	Joana Rios Da Rocha, Patrícia Pessoa, Lisa Afonso, Xana Sá-Pinto and J. Bernardino Lopes
Title:	Teach consensus, not controversy: Using science communication strategies to affect students' acceptance of evolutionary theory
Author(s)	Isa Marie Korfmacher, Christiane Konnemann and Marcus Hammann
	Paper Session 6B - Teaching and Learning with Educational Technology
Location:	Building: XΩΔ01, Room: 109
Chair:	Gregor Torkar
Title:	Understanding the complexity of the human circulatory system using educational materials with or without augmented reality support

Author(s)	Gregor Torkar, Tanja GregorČič and Andreja Dolenc
Title:	A comprehensive framework for understanding biology teachers' use of digital technology
Author(s)	Daniela Mahler and Julia Arnold
Title:	Biotechnology at school - digital or analog learning environment?
Author(s)	Julia Stich and Claudia Nerdel
Title:	Authentic Biological Dataset-driven Instruction Promotes High-Order Inquiry Thinking
Author(s)	Carmel Bar and Anat Yarden
	Paper Session 6C - Outdoor and Environmental Education
	Symposium 3 - The Call for Action in Environmental and Sustainability Education
Location:	Building: XΩΔ01, Room: 108
Chair:	Jelle Boeve-de Pauw
Title:	"Don't we all have a responsibility to act?" – Action competence as driver for young people's climate action
Author(s)	Carola Garrecht, Niklas Gericke, Nina Christenson and Ute Harms
Title:	Biology and science teachers view on critical thinking in sustainability education – The need for a multidisciplinary approach for action competence
Author(s)	Ragnhild Lyngved Staberg, Annette Lykknes, Teresa Berglund, Eli Munkebye, Eldri Scheie, Maren Skjelstad Fredagsvik, Tove Grete Lie, Marthe Lønnum, Sonia Martins Felix, Stephan Daus and Niklas Gericke
Title:	Effective Education for Sustainable Development
Author(s)	Wanda Sass, Eleni Sinakou, Els De Smet, Brigitte Pycke, Miette Plessers, Bea Merckx, Thomas Remerie, Eef Thoen, Sven De Maeyer, Vincent Donche, Peter Van Petegem and Jelle Boeve-de Pauw
12:30-13:45	Lunch
Location:	Restaurant A.Zorbas
13:45-15:30	Parallel Poster Session 2
	Poster Session 2A - Teaching Strategies and Learning Environments
Location:	Building: XΩΔ01, Room: 102
Chair:	Franziska Schisslbauer
Title:	"It is just really a different way to teach science" - Teachers' experience with citizen science
Author(s)	Julia Lorke and Maria Aristeidou
Title:	The effect of adult intervention in the development of science process skills
Author(s)	María Napal Fraile, Lara Vázquez Bienzobas, Irantzu Uriz Doray and Isabel Zudaire
Title:	The impact of lockdown on students' knowledge of evolution
Author(s)	Jelka Strgar
Title:	Explaining diversity – Educating about race: A study with biology student teachers
Author(s)	Franziska Schisslbauer and Arne Dittmer

Title:	A Systematic Review on the Use of Narrative Methods in Biology Education
Author(s)	Julia Zdunek and Jörg Zabel
Title:	Development of preservice biology teachers' PCK: Quantitative and qualitative analyses
Author(s)	Denise Bock, Daniela Mahler and Ute Harms
Title:	The role of study buddies in promoting interest in biodiversity and species literacy
Author(s)	Mario Stehle, Jonathan Hense and Annette Scheerso
Title:	Implementation of biotechnology topics into School Curriculum: findings of a case study on teacher training courses
Author(s)	Sara Großbruchhaus, Patricia Schöppner and Claudia Nerdel
Title:	Suggestion for biology classes using the poem The Baptism at the Savica
Author(s)	Andrej Šorgo, Tilen Kos, Nina Rupar, Sara Senčar, Sanja Zadavec and Tadej Zorko
	Poster Session 2B - Scientific Thinking, Nature of Science and Argumentation
Location:	Building: XΩΔ01, Room: 104
Chair:	Katrin Vaino
Title:	Change of Understanding of Nature of Science of Pupils of Secondary Classes of Scientific Inquiry in School Garden as a Learning Place
Author(s)	Torsten Kreher
Title:	"Post-truth" challenges and associated science education responses
Author(s)	Katrin Vaino, Anastasiya Astapova, Hans Orru, Konstantinos Korfiatis, Ana Valdmann and Oleg Popov
Title:	Students' explanations in model-based abductive reasoning about co-evolutionary phenomena
Author(s)	Johanna Penzlin, Dirk Krüger and Annette Upmeier zu Belzen
Title:	Potential of partly structured group-based negotiation on socioscientific issues to initiate more meaningful and deeper interaction
Author(s)	Maria Jafari, Maren Koberstein-Schwarz, Christina Priert, Florian Böttcher, René Leubecher and Anke Meisert
Title:	Giftedness in biology within the Cattell-Horn-Carroll theory – Basis for the development of a screening tool to identify gifted students in biology
Author(s)	Colin Peperkorn and Claas Wegner
Title:	Preservice Elementary Teacher's System thinking when Proposing Actions to Prevent Pandemics as COVID-19
Author(s)	Araitz Uskola and Blanca Puig
Title:	Language aspects in teaching biomedical subjects
Author(s)	Alesia Sharun and Tetiana Krushynska
Title:	Medical student's prospective reflection on studying microbiology
Author(s)	Tetiana Krushynska, Alesia Sharun, Iryna Zhernosekova, Iryna Stetsenko and Dmytro Stepanykyi

Title:	Conceptualisation of genetic variation as a disciplinary core idea through different levels of schooling
Author(s)	Helen Semilarski, Regina Soobard and Miia Rannikmäe
15:30-16:00	Coffee Break
Location:	1 st floor balcony
16:00-17:30	Parallel Paper Session 7
	Paper Session 7A - Teaching Strategies and Learning Environments
Location:	Building: XΩΔ01, Room: 109
Chair:	Lina Varg
Title:	Intentions, plans and teaching practices in upper primary school
Author(s)	Lina Varg
Title:	Increasing student involvement with ecological dilemmas through a SSIBL-based photo/video project
Author(s)	Rik Kooke and Micha Ummels
Title:	Educational escape rooms: Exploring the use of engaging problem-solving learning activities in science education
Author(s)	Georgios Villias and Mark Winterbottom
Title:	Fostering learning on socio-scientific issues with escape games
Author(s)	Alice Veldkamp, Johanna Rebecca Niese, Martijn Heuvelmans, Marie-Christine P.J. Knippels and Wouter R. van Joolingen
	Paper Session 7B - Students' Conceptions and Conceptual Change
Location:	Building: XΩΔ01, Room: 103
Chair:	Isabel Zudaire
Title:	No error but not a good answer: assessing progressions towards the biology paradigm
Author(s)	Francois Lombard, Camille Larpin, Marie Sudries, Séverine Perron and Laura Weiss
Title:	Bottom-up and top-down effects on the visual perception of data supporting the Balance of Nature or the Flux of Nature metaphor
Author(s)	Sabine Meister and Annette Upmeier zu Belzen
Title:	Content analysis of grade 12 students' conceptual understanding of core concepts in biology
Author(s)	Helin Semilarski and Anne Laius
Title:	Who do I look like more, mom or dad? An exploratory survey about young children's ideas about variation of traits
Author(s)	Isabel Zudaire, María Napal, Irantzu Uriz and G. Enrique Ayuso
	Paper Session 7C - Students' Conceptions and Conceptual Change
Location:	Building: XΩΔ01, Room: 108
Chair:	Georgios Ampatzidis
Title:	Students' misconceptions about respiratory processes using students' animations
Author(s)	Ana Valdmann and Hedy Suurmets
Title:	Friends or foes? Microorganisms in Greek school textbooks

Author(s)	Georgios Ampatzidis and Anastasia Armeni
Title:	Do bacteria really exist? Learning about micro-organisms in primary school
Author(s)	Zélia Anastácio and Catarina Gonçalves
Title:	Investigating how students move between different levels of biological organization when interpreting epigenetic representations
Author(s)	Annika Thyberg, Konrad Schönborn and Niklas Gericke
19:30	Conference Dinner-Social Event
Location:	Vintage Wine Bar & Bistro
Time	Friday, September 2nd
09:00-10:00	Keynote 2
Title:	Using Physical and Virtual labs for Experimentation in STE(A)M Education: From Theory and Research to Practice
Speaker:	Zacharias C. Zacharia
Location:	Building: XΩΔ02, Room: B205
Chair:	Marianna Kalaitzidaki
10:00-10:30	Coffee Break
Location:	1 st floor balcony
10:30-12:30	Parallel Paper Session 8
	Paper Session 8A - Students' conceptions and conceptual change; Students' Interests and Motivation
Location:	Building: XΩΔ01, Room: 108
Chair:	Andreas Ch. Hadjichambis
Title:	Biology teachers' self-efficacy and ability to diagnose and deal with student conceptions
Author(s)	Tim Hartelt, Helge Martens and Nina Minkley
Title:	What is "Environmental Citizenship"? A systematic review of the literature on teachers' perceptions
Author(s)	Yiannis Georgiou, Andreas Ch. Hadjichambis and Demetra Hadjichambi
Title:	Representations of gene models in Greek educators' conceptions: preliminary findings
Author(s)	Despoina Tsopoglou-Gkina and Penelope Papadopoulou
Title:	Connections of interest - Effects of interdisciplinary education on interest development in biology and PE
Author(s)	Niklas Kramer and Claas Wegner
Title:	The influence of incremental scaffolds during experimentation on the students' motivation in biology lessons
Author(s)	Svea Isabel Kleinert and Matthias Wilde
Title:	HPV-vaccinations from an educational perspective
Author(s)	Mats Lundström
	Paper Session 8B - Scientific Thinking, Nature of Science and Argumentation
Location:	Building: XΩΔ01, Room: 103
Chair:	Clas Olander

Title:	It's all about the competencies – Identifying and promoting giftedness in the natural sciences
Author(s)	Maria Sophie Schäfers and Claas Wegner
Title:	How do high school students and trainee teachers engage with contemporary biological research?
Author(s)	Ralph Levinson, Konstantinos Korfiatis and Stephen Price
Title:	Students meaning-making of a representation of the greenhouse effect - 'It is an easy representation, if you understand it'
Author(s)	Clas Olander and Johan Nelson
Title:	Use of external representations to support biological modelling
Author(s)	Benjamin Stöger and Claudia Nerdel
Title:	A short intervention that promotes the abstract reasoning scheme improves seventh graders' achievements in the topic of the cell
Author(s)	Reuven Babai and Wisam Bishara
Title:	Using student-created core idea maps to promote meaningful learning in science
Author(s)	Helen Semilarski, Regina Soobard and Miia Rannikmäe
Paper Session 8C - Outdoor and Environmental Education	
Symposium 4: Revisiting Plant Blindness in Biology Educational Contexts	
Location:	Building: XΩΔ01, Room: 109
Chair:	Penelope Papadopoulou
Title:	Investigating plant blindness: methodologies, challenges and possibilities
Author(s)	Irma Brkovic, Eva Nyberg and Dawn Sanders
Title:	Plant blindness intensity throughout the school and university years: a cross-age study
Author(s)	Alexandros Amprazis and Penelope Papadopoulou
Title:	How do plants obtain energy? A phenomenographic and pictorial analysis of upper secondary students' conceptions
Author(s)	Oier Pedrera, Oihana Barrutia and José Ramón Díez
Title:	Adult learners' conceptions on plant nutrition and ecosystem services provided
Author(s)	Olga Mayoral, Ana Ruiz and Tatiana Pina
Title:	Teaching species identification to pre-service teachers in distance field education
Author(s)	Arja Kaasinen and Anttoni Kervinen
Title:	Promoting students' interest in plants
Author(s)	Amélie Tessartz and Annette Scheersoij
12:30-13:00	Closing Session
Location:	Building: XΩΔ01, Room: 109
13:00	Lunch
Location	Restaurant A.Zorbas

ABSTRACTS

FOR PAPER AND POSTER PRESENTATIONS

Here follows the abstracts for the paper and poster presentations as they are placed on the detailed programme

Time	Monday, August 29th
18:30-21:30	Registration
	Welcome Reception-Social Event
Location:	Museums of the Pancyprian Gymnasium

Time	Tuesday, August 30 th
08:30	Registration
Location:	University of Cyprus
09:00-09:30	Opening Session
Location:	Building: XΩΔ02, Room: B205
	Welcome and Opening Speech be the Rector of the University of Cyprus, Tasos Christofides

Time	Tuesday, August 30 th
09:30-11:00	Keynote 1
Location:	Building: XΩΔ02, Room: B205
Chair:	Jörg Zabel

Problematization, narrative and fiction in science classroom

Catherine Bruguière and Denise Orange Ravachol

Our talk focuses on the didactic functions of problematization, narrative and fiction in the science classroom. To address these issues, we propose an approach that takes into account the epistemological specificities of biology (functionalist and historical sciences). It is from this epistemological basis that we will present, on the one hand, the theoretical framework of problematization developed for more than 20 years (Fabre & Orange, 1997; Orange Ravachol, 2012, 2017) in France and, on the other hand, the more recent notion of "fiction-realist" (Bruguière and Triquet, 2012, Bruguière, 2019) by situating it in relation to the work in biology didactics that borrows from the frameworks of narrative and/or fiction. Our two-part conference aims to bring these different theoretical frameworks into dialogue and to question their points of encounter and their divergences by using examples taken from our research work (blood circulation, molecular renewal, animal metamorphosis, scientific classification). To what extent can fictional narratives contribute to the construction of problematized biological knowledge? Under what didactic conditions can the transposition of biological knowledge in fictional narratives constitute an asset from a didactic point of view? How does the shift to extra-ordinary modes of reasoning allow us to move away from storytelling?

11:00-11:30	Coffee Break
Location:	1 st floor balcony

Time	Tuesday, August 30th
11:30-12:30	Parallel Paper Session 1
	Paper Session 1A-Teaching and Learning with Educational Technology
Location:	Building: XΩΔ01, Room: 109
Chair:	Anat Yarden

Perspectives on Social Media Use in Biology Education – A Qualitative Study with German Pre-Service Biology Teachers

Alexander Bergmann, Anna Beniermann and Alexander Büssing

Technological Pedagogical Content Knowledge (TPACK) represents the foundation for effective technology-based teaching. In this paper, we argue that knowledge about social media use (SMU) in biology education has become an integral part of biology teachers' TPACK and that biology teacher training needs to provide opportunities to develop professional knowledge about SMU. To identify such opportunities, we investigated the position of German pre-service biology teachers (n = 68, 6th to 8th academic semester) concerning SMU in biology education in a qualitative online study. We analyzed the data through qualitative content analysis. Based on the participants' written statements we distinguished between three groups (Pro-SMU, Conditional-SMU, Contra-SMU), each highlighting specific benefits (e.g., illustration of biological phenomena) and barriers (e.g., teachers' media literacy) of SMU in biology education. Our results may form a first hypothesis about the individual experience and professional knowledge that influences pre-service biology teachers' SMU in biology education. We discuss the potentials, barriers, and instructional ideas the participants considered and how they could inform pre-service biology teacher training.

An intervention to encourage plant appreciation in Life Sciences teachers - a case study

Benjamin A. Coetzer and Amelia L. Abrie

The well-established prevalence of plant blindness is a barrier to understanding the living world. In this study, Life Sciences teachers from the Gauteng province (South Africa) were invited to an information session on the phenomenon of plant blindness. A discussion on the negative influence of plant blindness for their teaching of Life Sciences was followed by an interactive, practical workshop in the form of a plant treasure hunt. The activity was intended to provide teachers with a strategy to facilitate meaningful interactions with plants as part of their daily teaching, by using a mobile plant identification application called PI@ntNet. The application allows the user to easily identify plants on mobile devices and instantly provides access to information, which could potentially increase educator's confidence in teaching about plants. The study was based on a modified PCK framework that focused on the influence of teacher knowledge and skills on the development of plant appreciation and confidence of teachers to teach about plants. Qualitative data were collected through an online survey, interviews with participants, weekly participant diaries and a final reflection about their experiences. Data were analysed and interpreted by means of content analysis and thematic analysis through emergent coding. This study found compelling evidence that an educator-focused intervention could interrupt the positive feedback loop of negative perceptions of plants between teachers and learners, and initiate a new positive feedback loop of positive perceptions towards plants.

Characterizing Ecology and Evolution ELearning Units Designed by Biology Teachers

Merav Siani, Carmel Bar and Anat Yarden

In the past years, eLearning has substituted traditional forms of teaching and learning and teachers need to be involved in designing eLearning units. However, little is known about the link between teachers as designers and the scientific practices and knowledge components they use in their instruction units. We aimed to investigate the extent to which high school biology teachers address knowledge components and scientific practices when designing

eLearning units focusing on ecology and evolution as part of a professional development (PD) course. We qualitatively mapped ecology and evolution eLearning units using three-dimensional scoring keys of knowledge components, scientific practices and the level of difficulty. We found that the teachers use mainly content knowledge in eLearning units they design, much less procedural and the least epistemic knowledge. We focused on two of those teachers and found that only one of them, a research-oriented teacher, used epistemic knowledge in the eLearning unit she designed. We also found a positive correlation between teachers' technological expertise and the number of epistemic questions they wrote. Thus, the PeTeL (Personalized Teaching and Learning) platform, a Moodle-based learning management system, gives affordances to the use of a variety of knowledge components. Future eLearning PD will aim to promote the use of diverse knowledge components and scientific practices in order to optimize eLearning.

Time	Tuesday, August 30th
11:30-12:30	Parallel Paper Session 1
	Paper Session 1B - Outdoor and Environmental Education
Location:	Building: XΩΔ01, Room: 108
Chair:	Marie-Christine Knippels

Teachers' self-efficacy and practices in ESD: A longitudinal study on the impact of professional development

Jelle Boeve-de Pauw, Daniel Olsson, Teresa Berglund and Niklas Gericke

This longitudinal quantitative study investigated teachers' development of self-efficacy and teaching practices relating to education for sustainable development (ESD) in four compulsory schools in a Swedish municipality. The teachers participated in a professional development program over three school years designed to support them in implementing ESD. The program was based on five seminars that supported teachers to locally discuss and experiment with the principles, complexities and challenges of ESD. Data was collected at five different time points using a questionnaire including scales measuring teachers' self-efficacy for ESD and their self-reported ESD practices. Results show that the teachers' self-efficacy was boosted early in the program, but it fell back to initial low levels after confrontation with practice. Through further experimentation in their own practices, the teachers' self-efficacy for ESD increased back to the initial level toward the end of the program. Furthermore, teachers started self-reporting actual implementation of ESD practices as the program progressed, and the correlation between teachers' self-efficacy for ESD and self-reported ESD practices grew. These results highlight the importance of providing teachers with long-term opportunities for bringing ESD into their own educational practice. The results also caution against using self-efficacy as an outcome measure in short-term professionalization initiatives.

The secondary school teachers' conceptualizations of the education for sustainable development and it's dimensions

Rolf Saarna and Anne Laius

The aim of the current study is to investigate the secondary school teachers' conceptualisations about the different dimensions and components of education for sustainability (ESD) against the matrix of ESD that includes three dimensions – environmental, socio-cultural and economical within three components – fact-based knowledge and skills, process-based knowledge and skills plus values and attitudes. The two research questions are posed for this study are as follows: (1) How differs the opinions about ESD among the different subject teachers of secondary school? and (2) What are the instruments used for assessing the sustainability literacy of secondary school students? The conceptualisation of different secondary school teachers were investigated through 12-item questionnaire and the assessment of sustainability literacy were analysed by systematic literature review including 18 reviewed articles. The results revealed very large differences between secondary school teachers and the holistic concept of sustainable development. The sustainability literacy tests are mostly used at the higher education level and not at secondary school level. The used tests vary at large scale both in content and quality.

Fostering Environmental Citizenship competences through Socio-Scientific Inquiry-Based Learning

Michiel van Harskamp, Marie-Christine Knippels and Wouter R van Joolingen

Environmental Citizenship (EC) has the potential to mitigate current unsustainable processes. Despite a growing focus on EC in biology curricula worldwide, science teachers experience a general lack of teaching approaches for implementing this form of citizenship in their biology lessons. A potential teaching approach for EC is Socio-Scientific Inquiry-Based Learning (SSIBL). SSIBL lessons make students ask personally relevant questions, on which they perform inquiry, and with which they take action. It thereby has the potential to promote the key competences necessary for EC. However, SSIBL has not been extensively tested in

classroom practice. The research question of the current study is: What potential does SSIBL have to develop EC competences in lower secondary students? In order to reach this aim, a Lesson Study (LS) with six science teachers and three educational researchers was carried out. A lesson module about the mining of elements for smartphones was developed and tested in two classes (average age 14.6). Audio recordings of the lessons, of student interviews, of reflection discussions with the teachers, and written educational materials from the students were collected. Results show that the module enables students to appreciate the complexity of the issue by using multiple perspectives. Opinion forming and decision making are stimulated too, but students struggle to use findings from their inquiry to develop solutions and undertake action. Concluding, SSIBL has potential to promote aspects of EC in classroom practice.

Time	Tuesday, August 30th
11:30-12:30	Parallel Paper Session 1
	Paper Session 1C - Teaching Strategies and Learning Environments
Location:	Building: XΩΔ01, Room: 103
Chair:	Tali Tal

The contribution of citizen science in an outdoor environment to improving achievements and attitudes towards science of students from low socio-economic status.

Lavi Oren, Nirit Lavie Alon and Tali Tal

Sometimes, schools teaching underserved students prioritize the higher-achieving classes, and low-achieving students may experience low-resourced teacher-centered teaching methods that do not require laboratories or using technological tools. Promoting higher-order thinking-skills in such classes is not common.

In this research, we suggest that citizen science, which is an emerging genre of scientific research that involves the public in the research, can benefit low-achieving students, with no additional resources. Our goal was to engage low achieving students in outdoor learning of ecology and add a citizen science component to the program and follow their attitudes toward learning science and their ecological understanding.

The participants were 81 8th grade students from a town in northern Israel. The project was in collaboration with Israel Nature and Parks Authority. A pre/post knowledge and attitude questionnaires were administered to the intervention class, and to two comparison classes: a low achieving class, and a high achieving class that studied according to the traditional curriculum, in school.

The results show significant difference between the intervention class and the comparison classes, in both attitude and knowledge aspects. We argue that learning in the outdoors and participating in a citizen science project, contribute to low-achieving students. This research may help integrate citizen science projects and outdoor learning in schools, in general and in those of under-served students in particular.

Subject student teachers' views on key environmental problems and their role as a solver of these problems

Eija Yli-Panula and Eila Jeronen

The study aimed to investigate what Finnish subject student teachers (SST) consider as key environmental problems, and how do they perceive their roles as problem solvers. Another aim was to study how are the mentioned local, regional and global environmental problems related to SSTs' interest in sustainable development (SD). In addition, the study examined how students' views on environmental problems relate to different dimensions of SD. The purpose of the study was to get an idea of the SSTs' ability to understand the entity of SD. The data was collected in 2019 using a questionnaire of Finnish six Universities. The answers of the SSTs (n = 113) were investigated using mixed method and data-driven content analysis. According to the results, SSTs perceive the main problems to be related to the urban environment and infrastructure, problems in ecosystems and problems related to indifference and lack of information. Climate change is perceived as the most important problem. SSTs recognize a wide range of environmental issues. Most SSTs mentioned environmental problems related to social and cultural sustainability, but less than a fifth of SSTs felt they are able to contribute to solve environmental problems themselves. In order to develop subject teacher education and SSTs' competence in SD, more research is needed into SSTs' knowledge of environmental problems and the factors that affect their competence in SD.

Scientific inquiry in mentor teacher training: a study about a biology-related mentor training and the impact on practical experience settings

Emanuel Nestler and Carolin Retzlaff-Fürst

Mentor teachers are learning companions at an important point: They provide preservice biology teachers support in practical experience settings. The preservice biology teachers and mentor biology teachers learn and teach in the practical phases in "third spaces" (Zeichner 2010) between the university and the school. Previous research work on mentoring has focused particularly on the competence to conduct conversations (Kreis 2012) or types of conversations (Niggli 2005). In this study we aim for general design principles to conduct to a biology related mentor teacher training. Therefore, we designed a biology-related mentor teacher training and evaluate the impact of this training on practical experience settings.

The results show effects on teaching quality, mentoring quality and the content of the mentoring dialogue. In a second step, these results are matched to 14 design principles (Malmberg et al. 2021).

12:30-13:45	Lunch
Location:	Restaurant A.Zorbas

Time	Tuesday, August 30th
13:45-15:30	Parallel Poster Session 1
	Poster Session 1A - Outdoor and Environmental Education
Location:	Building: XΩΔ01, Room: 104
Chair:	Gregor Torkar

Partnerships for Science Education: public health education and awareness with digital technologies

Dimitris Chalkidis, Carolina Santos and Tassos A. Mikropoulos

The COVID-19 pandemic has made a significant impact on all aspects of society, including education. The need for critical health education on public health has been made evident. The Partnerships for Science Education (PAFSE) project is a consortium of nine European Institutes that promotes public health education on communicable diseases with the aid of digital technologies. PAFSE consists of a transdisciplinary community of scientists who support the development of open digital educational resources and their inclusion in STEM educational scenarios, which are going to be implemented in schools. Our research team coordinates the development of Digital Learning Objects as well as the development of four educational scenarios focusing on the SIR (Susceptible, Infectious, Recovered) modeling of an epidemic, on the environmental and social determinants of health during an epidemic, on vaccine education and misinformation and on vaccine education for children with mild intellectual disability. The scenarios follow the inquiry- and project-based instructional model. At this work, we are presenting the scenario on SIR modeling of an epidemic and the importance of non-pharmaceutical protective measures, as an example of the educational material produced. After getting engaged and externalising their current knowledge, students actively handle simulations on modes of disease transmission, interactive maps and timelines of epidemic outbreaks and two educational SIR simulations. Afterwards, students are engaged in a three-part school project in which they use authentic epidemiological data in the SIR models. The scenario focuses on the practice of fundamental STEM and scientific literacy skills.

Nature play as a way of learning biology in early years

Marjanca Kos, Martina Mohorič, Luka Praprotnik, Sue Dale Tunnicliffe and Gregor Torkar

Nature play is defined as freely chosen, unstructured and open-ended interactions with and in nature. The aim of our research was to find out how does nature play in the forest provide young children with opportunities to experience biological phenomena with naturally occurring biofacts and living organisms and which key biology themes are most often experienced through the child's nature play. 21 four to six years old children from a public preschool in a suburb region in Slovenia participated in the study. The children were told to play in the forest. Their play was observed over a period of seven consecutive days, with each session lasting approximately one hour. Three randomly selected children in the group were equipped each time with small video cameras attached to their heads to automatically record sound and images from their perspective. The video recordings were transcribed and edited by two researchers. They were independently reviewed and analysed using "a read re-read" process to identify and consequently analyse the data. Altogether, 15 recordings were analyzed, for a total of 1083 minutes. Of these, 199 minutes (18.4%; excluding overlaps of 2 or 3 cameras) were recordings identified as play episodes where the children experienced biological phenomena with naturally occurring biofacts and living organisms. Three key themes were identified: 1) sensory experience, 2) biological diversity, and 3) ecological ideas and environmental understanding. We conclude that nature play is a valuable activity for young children as it provides opportunities to gain first-hand experiences in biology.

Mapping adolescents' nutritional knowledge

Matina Moshogianni and Martha Georgiou

A healthy diet beginning in the early years of life is essential to the development of good health in general and in particular to school performance. In Greece, nutrition is not directly taught to students, leaving them to obtain their knowledge of it haphazardly from school, their parents, the internet, the media, or peers. This study is the first part of a two-phase study. The aim of this first phase is to identify student's Athens participated knowledge of the nutritional value of various foods through means of the GeNSK questionnaire. One hundred sixty-two 16-year old students from different public schools of. A statistical analysis of students' responses identified many gaps in knowledge or misunderstandings on both basic and more specific nutrition questions. The results of this first-phase of our research indicate that while students have some knowledge of nutrition, these are insufficient to help them develop a healthy diet.

Inter-sectorial partnerships in implementing climate change education in the Israeli school system

Nofar Naugauker, Orit Ben Zvi Assaraf, Daphne Goldman and Efrat Eilam

Climate Change (CC) is currently the most existential threat confronting global societies, ecosystems, and the fabric of life on Earth. International organizations have long identified the important role of education in increasing the resilience of societies and their preparedness to withstand climate change calamities. However, research addressing the policy making aspects involved in developing and implementing CC curriculum at a national level are scarce. This study aims to explore how Israel negotiates its CC curriculum development and implementation through inter-sectorial collaborations between its Ministry of Education (MoE) and various stakeholders. Towards this end, the study maps out the various stakeholders involved in CC education policy development and implementation; and characterizes the nature of the relationships between the actors. Using semi-structured interviews, data was collected from 17 key actors including MoE policymakers, teachers' professional-development leaders, and teachers who teach CC. The findings revealed four main groups who collaborate closely with MoE, including: The Ministry of Environmental Protection (MoEP); Non-Governmental Organizations (NGOs); scientists and academic institutions; and the international GLOBE project. MoE was found to actively seek these collaborations and welcome their contributions. This recognition is institutionalized to the extent that scientists are invited to participate in shaping policy, and NGOs may be assimilated into the Ministry and influence from inside. These inter-sectorial collaborations facilitate the work of the Ministry in multiple ways. However, they also raise challenges, where authority needs to be continuously negotiated and asserted, as the MoE navigates its way toward CC curriculum development and implementation.

Unveiling the more salient components of Education for Environmental Citizenship in environmental Citizen Science initiatives: A systematic literature review of empirical research

Anastasia Adamou, Yiannis Georgiou, Demetra Hadjichambi and Andreas Hadjichambis Ch.

Environmental Citizen Science (CS) initiatives are assumed to contribute to the transformation of citizens into environmentally aware citizens. However, the potential of CS to support Education for Environmental Citizenship (EEC), and which are the more salient components of EEC (competences, actions, outcomes) in CS have not yet been explored. A Systematic Literature Review (SLR) was deployed, and thirty-one empirical studies (n=31) of environmental CS initiatives covering the last two decades (2000-2020) were retrieved. A content analysis procedure was implemented to examine how citizens' participation in environmental CS initiatives contributes to the EEC. Moreover, a meta-analysis (bivariate correlation analysis, k-means cluster analysis) was implemented in order to identify the more salient components of EEC in environmental CS initiatives. The findings indicated that the majority of the reviewed environmental CS initiatives enhanced citizens' EC competences; strengthened their personal and responsible environmental actions, and contributed to environmental outcomes. Finally, seven (7) keystone components (KCs) were revealed

among the identified EC competences, EC actions and EEC outcomes in the reviewed CS initiatives.

Symbolic experiences of nature on near-natural schoolgrounds

Anna-Lena Stettner and Armin Lude

One possibility to counter climate change and implement the goals of Education for Sustainable Development is to strengthen our children's connection to nature. An empirically proved way to strengthen this connection is enabling more nature experiences. The study presented here evaluates whether near-natural schoolgrounds offer the possibility for nature experiences, and investigates whether adults and students make symbolic nature experiences. Nature as an occasion for symbolization is an approach, developed by Ulrich Gebhard (2020), which focuses on the subjective and intuitive meaning of nature for the subject. In the first and second phase of this PhD study, already completed, go-along-interviews with teachers (n=5), school managers (n=7) and landscape designers (n=2) were conducted and evaluated through a qualitative content analysis. The results showed, that they rarely make symbolic nature experiences. If so, they remained in their professional role by using nature for thinking about its value for their students. The recent third phase consists of go-along-interviews with the students on their near-natural schoolground and will be evaluated according to documentary research. The aim is to explore whether students are using nature as occasions for symbolization and if symbolic nature experiences influence their decision about their favourite place on the schoolground.

How inclusive are the Environmental Education Centers in Greece

Rodanthi Lyraki and Marianna Kalaitzidaki

Environmental Education (EE) should be directed to all students including those with special needs. In Greece, an important institution for the implementation of EE are 53 Environmental Education Centers throughout the country that operate under the Ministry of Education and offer EE programs for school groups in their vicinity. The purpose of this study was to gather data regarding inclusive practices of these centers. A questionnaire was emailed to the 53 Centers directors. It contained 30 questions regarding their inclusion practices, staff experience in special education, attitudes towards inclusion, center accessibility, program accessibility and 34 Centers replied. Some make efforts in this area, while others, although recognizing this importance, need further action and state support in order to primarily improve their infrastructure. After all, as it turned out, the lack of accessible spaces is the main obstacle to the provision of special education programs by the EE Centers.

Teachers' experiences in a pilot project based on schoolyard biodiversity

Arnau Amat, Isabel Jiménez Bargalló, Chadia Rammou and Jordi Martí

This ongoing study aims to understand teachers' experiences when implementing a project on biodiversity with their students. In the pilot phase of this project, 26 elementary and high school teachers are going to implement the Teaching and Learning Sequences (TLS) designed by the authors of the study to work on how to improve the biodiversity of the schoolyard. Previous studies highlighted the importance of the setting of biodiversity projects to achieve a meaningful learning for students; some of them also showed the difficulties experienced by teachers when they have to deal with such complex interdisciplinary fields. Concerning methodology, a Qualitative Content Analysis from different data sources, such as diaries or interviews, will be conducted to identify the main challenges that teachers have to face this kind of projects. Even though the data collection will be conducted next spring, it is expected to identify the main arguments to explain the decisions made while implementing the TLS.

Good ways to teach species knowledge of plants...

Martin Feike, Susan Pollin and Carolin Retzlaff-Fürst

Biology is the science of living organisms and species knowledge is a basic detail of biological education. Further, species knowledge is unthinkable without the context of nature conservation. The substantial loss of biodiversity and alienation from nature makes efforts to promote species knowledge even more urgent. Therefore, different methods to identify plant species were investigated to find out if these methods show a differing influence in developing botanical species knowledge in the medium-term. In this study we used a pre-post design to analyze the output and impact of three methods of plant identification. Preservice teachers (30 students) received local plants for identification, to practice methodical approaches for the school setting - flora incognita (ID-App), nature guide (book) and 5-Minutes-Bio (teacher presentation). In a rotating process over several weeks, students tested these three methods for identification several times on local plants (n = 462). Each plant was only identified once. In order to document the knowledge before and afterwards, the names of plants were requested in an open response format. The results show a significant improvement of plant species knowledge after using the methods ID-app and the 5-Minutes-Bio, but not for the method nature guide (ID-app: p = 0,000; nature guide: p = 0,118; 5-Minutes-Bio: p = 0,003). According to these results, a digital definition or teacher presentation appears to be beneficial, whereas the self-explanatory method per book was less memorable.

Time	Tuesday, August 30 th
13:45-15:30	Poster Session 1B - Teaching Strategies and Learning Environments
Location:	Building: XΩΔ01, Room: 103
Chair:	Graça S. Carvalho

Diagnosing of valuing and decision-making competences in biology lessons

Malte Ternieten and Doris Elster

Valuing and decision making competences in the context of Education for Sustainable Development (ESD) plays an important role in the national educational standards (NBS) of biology. The students (of High-Schools) should be prepared to recognise and evaluate biological facts and justify their own or others' opinions. To address this problem, a Community of Practice (CoP) of teachers of a High School in Bremen and science educators of the University of Bremen was established. In close cooperation, a six-hour teaching unit in the ESD context on the topic of "peatland protection" was developed, tested and optimized in three cycles in the period from 2016 to 2020. In total, 181 students (95 ♀ | ♂ 86, aged 13 to 15) and seven teachers of High School participated in the study. The study is conducted according to the Design-Based-Research (DBR) approach based on McKenney and Reeves (2012). In close cooperation the members of the CoP develop and evaluate a model for the diagnosis of learners' written statements about socio-scientific issues in the ESD context. As a central result a theoretical based valuing and decision making competence grid is developed, evaluated and optimized. In addition to linguistic aspects, this so-called PARS model (In Partnership Competences Diagnosating) takes into account the thematically relevant ESD dimensions (Ternieten & Elster, 2020). The central results of the teacher interviews prove that the PARS model (Diagnose Grid) can be classified as a practical tool for diagnosing student performance in the context of ESD.

An app for teaching basic chemistry to biologists: spatial ability, prior knowledge, cognitive load and usability

Stefan Witzke and Claudia Nerdel

Basic knowledge of molecular structures is essential for understanding e.g. complex biochemical processes. To learn the interaction between the structure of molecules and chemical reactions, spatial ability is needed to mentally rotate and manipulate three-dimensional structures. Cognitive load of this task can be reduced by externalization. Prior knowledge moderates learning success in multimedia learning, too. In two studies, correlations between prior knowledge and spatial ability as well as learning success, cognitive load and usability aspects are investigated. In the first study, 12 participants learned with a three-dimensional structural modelling app in a pre-post-test design. Solving modelling tasks using the app and a video on theoretical principles formed the intervention. Pretest measured prior knowledge and spatial imagination. The posttest tested the same knowledge and the usability of the app was surveyed. In the second study another experimental group that uses a haptic construction kit is added to investigate the difference between digital and analogue modelling. Additionally learners CL of the tasks is assessed. In the data of the first study, Spearman's correlations were found between "spatial ability" and "usability" with $r = -.646$ ($p = 0.044$). Furthermore, "Perceived-Usefulness" and "Intention to further Apply" correlated with $r = .607$ ($p = 0.047$). Consequently, prior knowledge has no influence on usability aspects, but spatial ability does. The individual scales on usability aspects partially influence each other. The results will be supplemented by qualitative data, verified by a larger sample in January 2022 and presented together with data on Cognitive Load at ERIDOB 2022.

Learning trajectories in evolution education: analysing digital concept mapping using methods of learning analytics

Berit Katharina Czinczel, Daniela Fiedler and Ute Harms

Monitoring students' learning over time across the natural sciences and mathematics is an open field of research. In an interdisciplinary project, we seek to track and analyse students' learning trajectories through digital teaching units developed for the subjects biology, chemistry, physics and mathematics. Within the subject of biology, evolution is the central theory, yet it has proven to be a challenging topic for both students and teachers. Thus, we developed a 10-week unit covering evolutionary processes to identify students' individual learning trajectories. The unit is based on a project-based learning approach and organized in investigation cycles consisting of modified NGSS practices. Within the unit, we use recursive concept mapping to gain a deeper insight into students' development of conceptual knowledge. Concept mapping has potential to positively impact learning in biology, with digital concept mapping being particularly effective. Using this method, we hope to be able to track students' development of conceptual knowledge more precisely while simultaneously supporting students in learning about evolutionary processes. We also expect to be able to identify students' misconceptions which may impede learning about evolution. We anticipate that using concept mapping will grant us additional insights into students' acquisition of conceptual knowledge about evolution and help pave the way for more individualized support in evolution education.

Learning communities for the professional development of digital teaching

Melanie Ripsam and Claudia Nerdel

A wide range of digital media characterizes the everyday lives of young people. In addition to subject-specific competencies, students must acquire digital skills and abilities. In order to prepare the adolescents for everyday life and professional fields, the school as an institution must constantly develop further. In view of this, the BMBF-funded joint project DigitUS aims to support schools with the help of learning communities. Since school is shaped or influenced by different professions, the cooperation of the actors is an important success factor for the further development of teaching. DigitUS investigates the conditions for success of learning communities for learning-effective STEM lessons with digital media. In the study, school-wide learning communities were established. They work with different expertise on media and teaching concepts. The focus is to promote the professional knowledge of STEM teachers. At the conference, the concept of the school-wide learning community will be presented using science, especially biology, as an example. The learning communities are currently in the pilot phase. It will be examined whether the test instruments depict the previous experiences and the use of media in a valid and reliable way. The evaluation will be done with the help of statistical data analysis in SPSS. Interviews will capture participants' assessments of the concept of the school-wide learning communities. The thought protocols will be evaluated qualitatively. The results of the pilot project will be presented and discussed at the conference.

An Investigation of Pre-Service Biology Teachers' Enacted TPACK.

Alexander Aumann and Holger Weitzel

In order to exploit the potential of digital technology in science classrooms, teachers must be prepared for their effective usage. The Technological, Pedagogical, and Content Knowledge (TPACK) model provides a framework for analyzing the media-supported teaching of subject-related content. The model is also frequently used in science contexts. However, to date, studies in the field have been underrepresented compared to self-reports and knowledge measures. Present studies also rarely included contextual factors in detail, although the TPACK construct is considered highly affected by situational influence. Accordingly, a more comprehensive as well as individual analysis is needed. This paper presents a mixed-method approach that is used to examine the extent to which pre-service biology teachers use TPACK to plan, implement, and reflect on media-supported instruction during their internship semester. They will be asked to implement a lesson in which their students create explanatory videos related to a biology subject matter. Data will be collected on three exemplary cases via planning artifacts, classroom observations as well as reflection interviews. The evaluation of the three data sources will be conducted using a rubric consisting of quality criteria of biology teaching, instructional design of media, and empirical findings of the specific media use. Reflection interviews will be analyzed in additional depth via qualitative content analysis. The results of the study will be available in June 2022 and presented at the conference in the form of a poster.

The shell model as a planning model for distance teaching

Annemarie Rutkowski, Christian Förtsch, Dagmar Traub, Monika Aufleger and Birgit Jana Neuhaus

The supply–usage-model (Seidel, 2014) summarizes instructional aspects influencing learning outcomes. Based on empirical studies on instructional quality, the shell model was developed as a planning model for conceptual instruction in biology. It consists of three shells, (1) relationship shell, including general instructional quality, (2) conceptual shell and (3) content shell, both including biology-specific instructional quality. The conceptual shell links specific content taught within the content shell to more general concepts (core ideas), so that conceptual knowledge can be fostered. (Dorfner et al. 2019). The COVID-19 pandemic led to a new form of instruction - distance teaching. With this, new problems have risen for biology teachers which make it necessary to analyze how distance teaching can be successful (Voss & Wittwer, 2020). Therefore, the following questions were raised: (1) Which problems do occur in distance teaching and where are these problems located within the shell model? (2) Can biology lessons within distance teaching be planned using the shell model? (3) Does the shell model have to be adapted to plan distance teaching?

Teachers were informally interviewed. Mentioned problems were catalogued and addressed by using the shell model. Possible solutions were formulated within three key messages showing that the shell model can be used for planning distance teaching, although adaption is necessary. This leads to several lesson units spanned by a large unit, all planned using the shell model. Furthermore, it shows that classroom processes are influenced by several contexts. Therefore, including the shell model within the supply-usage-model (Seidel, 2014) seems promising.

Pre-service Teachers' Behavioral and Control Beliefs on the Subject-specific Use of Digital Media in Biology Classrooms

Maja Funke and Jörg Zabel

In order to prepare pre-service science teachers for the subject specific use of digital media in biology classroom, teacher training needs to adapt. According to the Theory of Planned Behavior (TPB), training courses influence teachers' use of digital media within teaching by affecting action-related attitudes, perceived norms and perceived behaviour control. This is possible through the change of their underlying beliefs. To identify these beliefs, pre-service biology teachers' written reflections on the subject-specific use of different digital media were analysed within this study. Every week, 21 groups of four pre-service teachers were familiarized with a digital medium or application within a different subject-specific context and reflected on its use by writing statements. Using qualitative content analysis, all statements (n = 85) were categorized based on the TPB. It turned out that while pre-service teachers expressed mainly positive beliefs and intentions regarding all media, they did not judge these media's advantages and disadvantages across the board. Instead, they named various action-related beliefs in context of different media use in the biology classroom. For teacher training, these findings suggest confronting pre-service teachers with a variety of different media in subject-specific contexts in order to foster a reflected use of digital media in science classrooms. Furthermore, the identified beliefs can inform the development of a TPB-based measuring instrument to evaluate the effect of subject-specific courses.

Reflections of prospective biology teachers on the construction and use of smartphones as microscopes in biology classes

Vida Lang and Andrej Šorgo.

Mobile smart devices are in the pockets of virtually all young people, but for one reason or another they are rarely used in biology classes, even though many opportunities are opened up. This paper presents an example of a task given to prospective biology teachers: They were asked to build a microscope from a smartphone and household materials and to prepare a reflection on their work. The main research questions were whether they saw the usefulness of a smartoscope and what they thought about the ease of using a smartphone in biology class. We were also interested in whether they intended to conduct such experiments in the

future as teachers or what reservations they had. By analyzing the principal components, we obtained 4 components that met the criteria. The components show that students perceived the use of smart mobile devices as 1 - pleasant and user-friendly, 2 - enjoyable and convenient, 3 - satisfying and trusting, and 4 - with the intention to continue using them.

Teacher's perceptions of objectifying explanatory black-boxes in the biology classroom

Gur Arie Livni Alcasid and Michal Haskel-Ittah

Mechanistic reasoning is an important part of science, both an explanatory framework and a methodology, enabling scientists to explain, predict and control phenomena. As such, mechanistic reasoning has become an important aim in science education. However, as mechanisms taught in the classroom become complex, it is clear that every mechanistic explanation includes at least some explanatory gaps in it. Therefore, it becomes imperative to provide teachers and students with tools to recognize, assess and deal with explanatory gaps in mechanistic explanations, sometimes referred to as black-boxes. This study was designed to understand how teachers, familiar with the idea of black-boxes, describe the black-box object in the context of biology education and perceive the affordances of talking about it in an explicit manner in their classroom. For this purpose, we conducted a professional development course, aimed at advancing biology teachers' understanding of the idea of black-boxes. Of the course's participants, three outstanding teachers were interviewed in a semi-structured interview. While coding teachers' description of the black-box object, we found all three teachers alternated between three different descriptions of the black-box object, as they mentioned six different affordances of using the idea of black-boxes in the classroom. Furthermore, data suggest that discussing different affordances elicited different descriptions of the black-box object. Findings hint at an affordance of using the black-box term in an explicit manner, as this might lead to a consolidation of its various meanings into a uniform object.

Elaboration and validation of experimental activities on fermentation/respiration using easily-accessible materials to be implemented in Mozambique

Graça S. Carvalho, Manecas Azevedo and Paulo Mafra

The General Secondary Education (GSE) national programme of Mozambique aims for a dynamic and flexible curriculum with transversal content approaches. Experimental microbiology activity has this objective and presupposes the manipulation of laboratory materials. This study aimed to find out how experimental microbiology activities might be practicable in Mozambican GSE schools, which require the use of easily-accessible materials. The study focused on the 12th-grade (17-18 years). The analysis of the microbiology contents of Mozambique's 12th-grade national programme and the respective single textbook showed that the unit Cytology refers to yeasts and other microorganisms in the alcoholic fermentation, presenting a strict protocol providing no reflective thinking and using conventional laboratory materials, which are inaccessible in low-income countries like Mozambique. Therefore, we elaborated two experimental guides (for teachers and students), promoting students' active participation in the teaching-learning process and adapted to the Mozambican reality. Initially, the fermentation/respiration activity was developed at the University of Minho (Portugal) using its laboratory resources. During the activity, the researchers reflected on adapting it to the Mozambican reality. Both guides were elaborated and then validated by 10 GSE biology teachers of the town Nampula (Mozambique). Teachers answered a questionnaire and considered that the materials used in the experimental activity could be found easily and make the activities easy to do, having a positive impact on how they can teach fermentation/respiration in the classroom and students' learning. This experimental activity will also help students understand yeasts as living beings and recognize their importance for humans.

Time	Tuesday, August 30th
13:45-15:30	Poster Session 1C - Students' Conceptions and Conceptual Change
Location:	Building: XΩΔ01, Room: 102
Chair:	Michal Haskel-Ittah

Analysis of Covid19-related biological mechanistic information presented in the media

Shanny Mishal and Michal Haskel-Ittah

Since the Covid-19 outbreak, information about the virus and the disease it causes flooded the media. More than five billion search results for "covid-19" currently exist in Google. This flood of information served as an opportunity to study the manner by which biological mechanisms are presented to the public with the aim of deciphering how to prepare our students to manage such complex information. While differentiating between fake and real information is an important part of the process, this is out of the scope of this study which is focused on the presentation of real information about mechanisms in the media. By analyzing 108 media reports, we found that the mechanistic information presented in the media is divided into four types of mechanistic structures. The majority of it is in a structure type which includes "black boxes", gaps between one part of the mechanism to the next. Other types include obscure information or complete mechanisms. We also found that specific parts of the analyzed mechanisms are more often fully described than others. Based on our finding it is reasonable to assume that students will encounter partial biological-mechanistic information in the media. Given that understanding those mechanisms is important for laypeople's ability to evaluate and use scientific information, this calls for preparing our students for identifying and handling partial information. The mechanistic structures identified in this study may form as a basis for discussing partial information in the science classroom.

Students' conceptual understanding of core ideas in biology

Helin Semilarski and Anne Laius

Biology education faces the major problem of how to educate young people in a constantly changing world. People need to be capable of making biologically justified decisions in their everyday life, especially regarding their health, e.g. vaccination, diet, type of treatment. This emphasises the need for every person to have at least basic knowledge of biological concepts and be able to apply competences to solve different everyday problems. They have been stated by National Research Council. The standards in the next generation science standards (NGSS) reflect students biological needs (NGSS, 2013). Conceptual understanding is needed to develop higher level abilities that would enable them to apply their knowledge. The aim of this study is to determine grade 12 students' profiles of achievement in biology. 215 12th grade students participated in this study. The main results enabled a distinction between the students' latent profile models so as to detect the biological ideas and concepts that differentiated the students' conceptual understanding. These findings are discussed.

Primary student's ideas about biodiversity contents in a biodiver project

Chadia Rammou, Arnau Amat, Isabel Jiménez Bargalló and Jordi Martí

This study aims to identify the evolution of students' ideas about biodiversity contents. In the pilot phase of PATIS BIODIVERS, 26 primary and high school teachers are going to conduct different Teaching and Learning Sequences to improve biodiversity in schoolyards. We will collect the data using a mixed-method approach with different focus groups, drawings, and observations. In previous studies, it shows us how important it is to understand and know students' ideas to help them improve in their knowledge.

Urban and rural children's perceptions of farm animals and pets

Eliza Rybska, Paulina Smoła and Costas Constantinou.

The aim of the work was to check how the place of residence of grade 3 and 4 students of primary school influences their knowledge and perception of domestic and farm animals. In Poland, the place of residence is strongly connected with experiencing nature. We wanted to examine the relationship between nature experience type (e.g., direct or indirect) and pupils'

knowledge and perception of farm animals and pets. 83 pupils (aged 8-10) were asked to draw a farm animal and a pet, and were then interviewed using a semi-structured protocol. Knowledge about animals of children living in the countryside and in the city is varied; they have different experiences with nature and perceive domestic animals and farm animals differently. Children living in the countryside are more likely to have contact with farm animals on a daily basis in contrast to students living in the city, leading to their richer, more detailed knowledge about animals. In their drawings, children also present animals differently highlighting different features and emphasizing different structural elements. We discuss implications of this research for educational, sustainability and environmental policy.

Where do plants get their mass from? Using drawings to assess secondary students' modelling skills and their ideas about plant growth

Zofia Chyleńska, Eliza Rybska, Joanna Wojtkowiak, Pantelitsa Karnaou and Costas P. Constantinou

The purpose of this study was to diagnose the modelling skills and concepts of school students at different educational levels, about the process of photosynthesis. The study was conducted in three schools, with students of grades 5, 7 and 10. The students responded to a questionnaire which consisted of two parts. In the first part students answered questions about plants (whether they grow them at home, what is the role of plants in supporting life on Earth, what living processes do plants perform, and what plants do at night). In the second part, the respondents were asked to make a model in the form of a drawing answering the question "Where do plants get their mass from?". The answers from both parts were categorized, coded and scored. As could be expected, age/educational experience/maturation had an important influence on students' responses and their drawings. Within each age group, we found that the more students knew, the better their drawings worked as models of the process of photosynthesis. The findings yield baseline data for students who have never been taught about models and modeling in science. We discuss implications for science education reform in Poland.

Evolution Education: Difficulties in Population Thinking and how it develops in Upper Secondary School

Martin Scheuch, Gerald Fuchs, Christine Heidinger and Heidemarie Amon

Population thinking was not less than a scientific revolution, enabled to explain many observations, and linked processes in the theory of evolution. Therefore, population thinking is important in evolution education for understanding the mechanisms of evolution. Everyday conceptions in evolution education are known to be stable; concerning population thinking students are struggling with individual adaptation as well as essentialist conceptions of species. In this long-term study, we are going to focus on the development of population thinking and the difficulties the students face during upper secondary school: which population related concepts (or their counterparts from literature) are applied by students to explain evolution? Three students were interviewed six times each over five years in upper secondary school in Austria to track the conceptual development. Qualitative content analysis was applied to reconstruct the conceptions and the learning. At the beginning in grade 8, all students think of individuals adapting to environmental changes through mechanisms with a certain insight to the need of adaptation. After the first teaching this changes and then an essentialist thinking is applied via thinking in two groups: one with a favourable trait which is surviving and another without which is disappearing. This thinking remains fairly stable until the last interviews. Definitions of population concepts were asked in grade 10 and 12, the students gradually improved. Only one of them reached a complete understanding and could apply the concept. The other two could define it, but mixed it with demographic definitions in different examples they used for explaining.

Primary school pupils facing a eutrophication problem: causes, consequences and solutions.

Mercedes Jaén García, Isabel Banos-González, Patricia Esteve-Guirao and Magdalena Valverde Pérez

The current serious socio-environmental crisis requires an educated and critical citizenry, which is why it is essential to address this type of problems at school, from an early age. This paper analyzes the implementation of an activity with 102 pupils from 5th and 6th grade about a eutrophication problem affecting a relevant ecosystem in their region, in order to assess the decisions that primary school pupils are willing to make when facing the problem. Based on the problem statement, pupils work autonomously on relevant data and evidence, allowing them to know the causes, consequences and become involved in the decision making process regarding possible solutions to the problem, by writing a letter to the responsible administration. The results show that, although the majority identified fertilizers as responsible for the problem and adequately related it to the consequences, when it came to demanding solutions, they proposed the use of wetlands as a means of preventing nutrients from ending up in the lagoon, but few pointed out that this measure must be linked to a control at source of these wastes to be truly effective. This trend could be related to the strong influence of certain widely shared social perceptions in this region, in which agriculture is highly valued and defended in the face of scientific evidence which shows it to be responsible for the problems generated.

Conceptions of students and teachers about the biological impact of climate change

Britta Bueker and Dominik Begerow

Anthropogenic climate change and its impact on the biosphere is an urgent and global issue that comes with many environmental, economic and social challenges. The biological aspects of climate change are complex, as climate affects biological systems at all levels, including individuals, populations, species, interaction among species, communities, and ecosystem. Due to this complexity, the understanding of biological aspects of climate change is challenging. To gain better insights in students' understanding of climate change and its biological impact, the main goal of this study is the identification of existing conceptions and alternative conceptions of high-school students, university students and teachers and how they are influenced by age and educational background. Therefore, we surveyed German high-school students, university students and teachers (N = 231) using a qualitative approach. In a paper pencil test, teachers and students were asked to describe biological outcomes for two different scenarios if climate changes. The results show that given answers represent all scientific categories. The comparison of given answers with scientific ideas also reveal the co-existence of scientific and alternative conceptions. Moreover, our findings show, that educational stage and age directly influence the complexity of answers and number of mentioned categories. The consideration of conceptions is important for successful biological education. Our findings show that students' - and also teachers' - understanding of the complex field of biological impacts of climate change is limited, emphasizing to strengthen scientific conceptions and the link between different scientific fields.

Combining behavioral and neuroimaging research on university student error detection in biological models

Joe Dauer, Mei Grace Behrendt, McKenna Elliott and Caron A.C. Clark

As university biology students gain greater knowledge, they also learn to create and evaluate the quality of biological models. The aim of this study was to determine whether students' detection of errors in biological models relates to activity in neural regions associated with foundational brain processes of inhibition and error detection. 34 university students completed a validated task of inhibition and error detection (go/no-go) and a biological model evaluation task while undergoing MRI. The model evaluation task included models with and without errors from evolution, genetics, physiology, and ecology. Students performed well on the model evaluation task, accurately responding on more than 66% (M = 23.75 out of 36 models) of all models. Students with higher model evaluation accuracy generally showed more activity in left inferior frontal cortex. Importantly, students showed higher activity for incorrect relative to correct models in the same ACC region they activated when inhibiting their responses during the go/no-go task. This suggests a possible generalizable process of error detection in that the same ACC region is being used when you stop yourself from making an erroneous response and when you see an incorrect model. When teaching for conceptual change, error detection may be a skill to teach that could have benefits for students' abilities to recognize their own misconceptions. Since models are ubiquitous in biology, detecting errors in models may be an essential step to changing student misconceptions about biological systems.

15:30-16:00	Coffee Break
Location:	1 st floor balcony

Time	Tuesday, August 30 th
16:00-17:30	Parallel Paper Session 2
	Poster Session 1C - Students' Conceptions and Conceptual Change
Location:	Building: XΩΔ01, Room: 109
Chair:	Michael Ewig

Narrative Explanations and Temporality of Natural Selection: A Case study in a French Grammar School

Fabienne Paulin, Catherine Bruguière and Jörg Zabel

The study presented questions the cognitive potential of the narrative form in teaching natural selection. One of the problematic aspects of this teaching is the temporality of changes that occur in a population in the face of environmental selection pressure. These changes occur over generations through differential reproduction. The generational timing of a natural selection process is a documented obstacle in the teaching of evolution (Gregory, 2009). We mobilized the narrative form to solve an exercise on natural selection with students in a science class aged 15 to 17. 12 students produced an explanatory narrative that we analysed with epistemological criteria (presence of initial variation, identified selection pressure, reproduction over several generations explained) (Huneman, 2011) crossed with temporal markers. The results are contrasting. On the one hand, the narrative seems to allow a relevant structuring of the Darwinian explanation with the identification of an initial state, a complication and a final state and without finalism. On the other hand, the students focused on a particular moment (the predation of mice by a cat) which is treated here as a singular event and therefore restricted to a short time. This exploratory study opens interesting perspectives on the use of narrative forms in biology teaching.

Reading a fictional storybook in a primary biology lesson: questioning the reasons of development of life on Earth

Frederic Charles

This presentation aims to explore the didactic potentialities of a fictional storybook named “To have class on the Moon” (Hare, 2019). This children’s literature book takes place on the Moon and shows a teacher and his pupils dressed in astronaut’s realistic outfits. The content analysis of the narrative shows the potentiality to approach biological contents linked to the necessary conditions of life’s development. This study was undertaken in two classes of the third year of a French primary school, with pupils aged from 8 to 9 years old (N=50). A teaching and learning sequence was built by the research group and implemented by two female teachers, which have been involved in our collaborative research group. We will present the data regarding the first session, which aims to assess how the storybook’s illustrations may encourage the pupils into a questioning about the necessary conditions for the development of life. The analysis of two collective discussions proves that these pictures offer a first activity full of sense and motivation for pupils. Moreover, this first data allows us to say that the interpretation of this illustration in biology lessons can be a way to engage young pupils in problematization about the necessity of temperature, air, water, and sun for the existence of life.

Plain Language Texts in Biology Classes for Fifth-Graders – Influences on the Declarative Knowledge and Attitudes towards them

Melanie Schaller and Michael Ewig

German schools show a heterogeneous student body concerning language competences due to inclusion and migration. Along that, the concept of Plain Language (Leichte Sprache), which addresses groups in society that can also be found at school (for example people with migration background) and is supposed to lower comprehensibility barriers in texts, becomes increasingly prominent in German society. The modification of biology schoolbook texts following the rules of Plain Language shows the possibility to lower comprehensibility barriers well known from texts dealing with biology issues. Therefore, a pre-post-test design with mixed-methods by the use of questionnaires and interviews was conducted to find out about the influence of Plain Language texts on the amount of declarative knowledge in fifth grader’s biology classes and the attitudes towards the modified text variants by students and biology teachers. Although a significant increase of declarative knowledge in both the experimental (n = 61) and control group (n = 39) could be found, the pre-study showed no significant differences between both main and subgroups concerning different needs for language support. Furthermore, students show different opinions about Plain Language, although students with and without expected need of language support respectively show a more positive rating. Aside from that, some aspects of Plain Language are rated negatively (e.g. the segmentation of compounds) while others positively (e.g. large font) in all groups. The results can be of use regarding international concepts for the use of Plain Language in numerous countries and the conception of biology schoolbooks.

Piloting the students' learning activity: the didactic language gestures of the biology teacher

Lhoste Yann

In this contribution, we would like to focus on certain teaching skills that we call didactic language gestures (DLG), which seem to us to be decisive for the scaffolding of the learning of biological concepts by the students. The aim is therefore to characterize the way in which teachers help students to pose and construct the biological problems that are at stake in scientific investigation sequences.

Time	Tuesday, August 30th
16:00-17:30	Paper Session 2B - Teaching Strategies and Learning Environments
Location:	Building: XΩΔ01, Room: 103
Chair:	Lars Meyer-Odewald

Competence Matrices in Biology Education – An Instrument to Encourage the Basic Needs Fulfilment of all Students in Heterogeneous Learning Groups?

Marlen Grimm and Carolin Retzlaff-Fürst

The aim of the study is to develop and evaluate concepts for inclusive biology teaching and learning. In the sense of the self-determination theory and in a broad understanding of inclusion the common basic needs of all students (for autonomy, competence and relatedness) determine the basis for the teaching concept and the research design of the study. The research question is, to what extent the use of competence matrices influences the fulfillment of the basic needs of students in heterogeneous biology classes. Therefore, the study compares the basic need fulfillment of sixth graders in learning environments with and without competence matrices (tables with different competencies at different levels). For the intervention, a competence matrix was developed, implemented and investigated in a biology unit about invertebrates (grade 6). The opportunity to work with live animals in the classroom makes this topic particularly suitable for inclusive classes and differentiated learning approaches. The study was evaluated in a quasi-experimental design (N = 96) with control group. The pre-post comparison indicates that the experience of autonomy and relatedness are encouraged more strongly in learning environments with competence matrices than in regular classes without competence matrices. However, the intervention has no significant effect on the students' experience of competence. In both groups there was a slight increase from pre to post for this basic need. As the study is embedded in a complementary mixed methods design, these results currently get supplemented by qualitative results from an interview study.

Comparing experimental protocols as method of teacher education in the context of scientific inquiry

Lars Meyer-Odewald, Kathrin Ziepprecht and Rita Wodzinski

During biology lessons teachers need to be able to identify student difficulties in the experimentation process and support them appropriately. To do this they must have good diagnostic skills and be familiar with the phases of the experimentation process themselves. One way to promote their competencies is to look at student protocols which are structurally based on the steps of experimentation. In this case the protocols function as a learning aid where the students' mistakes can be worked out. It has already been shown in other contexts that it can have positive effects on learning if several learning objects are specifically compared instead of looking at them individually, as their characteristics become more apparent. In the field of teacher education, however, there are hardly any investigations in this regard. The present study therefore examines whether the way prospective teachers work with experimental protocols has an impact on the development of their stated competencies. For this purpose, prepared protocols with a biological focus are used as learning material as part of a university course. The intervention group is asked to compare the protocols with each other, while a control group works on the same material without comparing them. The competencies of all prospective teachers are compared in a pre-posttest design. Furthermore, the experiences of the students processing the protocols are examined.

Future-oriented Pedagogy for Molecular Biology Inquiry-based Learning in High School Biology Laboratories

Dana Sachyani, Pirchia Tamar Waxman, Irit Sadeh, Shoshana Herman, Mor Levi Ferber, Michal Yacobi, Omer Choresh, Efrat Link, Shiri-Rivka Masa, Samuel Ginsburgand and Michal Zion.

Integrating molecular biology lab activities into open inquiry-based teaching is an innovative, unique process that has taken place in Israeli high schools since 2018, becoming part of biology studies for 11th and 12th-grade students. Engaging these students in lab techniques and practices in this field enables them to deal with the often-abstract concepts of the molecular world, enabling them to address questions currently on the forefront of science and make their learning relevant to the 21st century. The study's purpose was to examine how molecular biology inquiry activities in high school can incorporate and promote Future-Oriented Pedagogy (FOP). This pedagogy is a forward-looking model based on six principles that inspire learning in the education system that focuses on the needs most relevant for 21st century students. The study was conducted by analyzing semi-structured interviews with teachers involved in this program and by observing teacher training days. The results indicate that this program facilitates the promotion of inquiry skills and enables the implementation of FOP principles. Our study has shown that bringing molecular technologies into the high school biology lab bears great potential in promoting FOP as part of the open inquiry-based teaching.

Elementary school students' evaluation of explanations to biological phenomena

Yael Shtechman, Marida Ergazaki and Michal Haskel-Ittah

The ability to reason mechanistically is crucial for understanding and evaluating scientific knowledge. The literature offers different views regarding children's ability to reason about mechanisms, on the one hand describing children's intuitive preference for mechanistic explanations about biological phenomena and on the other, describing children's or even adults' tendency to accept non-mechanistic explanations (e.g., teleological). Considering the above, we designed a case study to explore how elementary school students evaluate different types of explanations when their explicit goal is to explain how a biological phenomenon may occur. The participants were 58 conveniently selected 2nd-6th graders attending public elementary schools in Israel. They gave us individual, semi-structured interviews, in which they were asked to evaluate different explanations (circular, teleological, mechanistic) to three plant-related or human-related biological phenomena. Our findings show that children are able to recognize the explanatory power of mechanistic explanations and use it to explain their preference for such explanations over others. Children seemed to distinguish between different sub-categories of mechanistic explanations (passive mechanistic explanation vs. active mechanistic explanation), and conceptions about the involved entities may guide the type they preferred (e.g. (mis)conceptions about plants and their ontological status). Our findings shed light on the toolkit children use while reasoning about the appropriateness of different types of explanations about how a biological phenomenon may occur and imply that an explicit discussion on the differences between explanation types could actually begin at the elementary school level.

Time	Tuesday, August 30th
16:00-17:30	Paper Session 2C - Teaching Strategies and Learning Environments
Location:	Building: XΩΔ01, Room: 108
Chair:	Michael Reiss

Investigative school research projects in biology: Effects on students

Wilton Lodge, Michael Reiss and Richard Sheldrake

Science education is sometimes orientated around students learning science by doing science. Investigative research projects may be intended to reflect some aspects of science more authentically than other teaching and learning approaches, such as confirmatory practical activities and teacher demonstrations. What remains under-researched is what the effects on students are as a result of undertaking such projects. In this study we collected data from students who were participating in investigative research projects. Our research question is 'How do secondary school students participating in a biology research project see science and themselves in relation to it?'

Twelve 12-18 year-olds who were undertaking biology research projects in England participated in 1:1 interviews in 2021. There was an association between the participants' motivation for engaging with the investigative research project and their science identities, with many of them articulating that the project provided them with an "authentic" experience of what "real scientists" do. Participants were nearly always positive about taking part in a research project; this was particularly the case for those students who presented their findings at a conference, where presenters received feedback from peers and members of the science community. For some of the participants, engaging in an investigative research project afforded them opportunities not only to develop their scientific inquiry skills but to gain a deeper understanding of the epistemological dimensions of science and its connection with historical, cultural and social values. This greater appreciation and insight into the nature of science increased their science-related career aspirations.

Concept mapping as an adequate retrieval-based learning opportunity in biology

Sina Lenski, Mirlinda Mustafa and Jörg Großschedl

Dealing with ecosystems in biology is difficult for students as it implies understanding the interrelations between concepts. Concept maps support students to acquire the necessary conceptual knowledge. Concept maps can be constructed in the presence of the learning material (study-based concept mapping) or without present learning material from memory (retrieval-based concept mapping). Studies on college students show that retrieval-based concept mapping supports learning more effectively than study-based concept mapping. Regarding concept map-quality, which is related to the number of concepts, previous studies show that retrieval-based concept mapping performed fewer propositions than study-based concept mapping during the learning phase. As concept maps are supposed to create connections between new information and prior knowledge (elaboration), previous studies show that retrieval-based concept mapping constructed significantly more elaboration-suggesting propositions. This intervention study aims to examine the effectiveness of retrieval-based concept mapping in the subject of biology. In a sample of N = 129 students from middle school, students learned either by performing study-based concept mapping or by performing retrieval-based concept mapping. Conceptual knowledge was assessed via pre- and post-test. Results revealed that the retrieval-based concept mapping outperforms the study-based condition regarding learning performance: Students in the retrieval-condition used more elaboration-suggesting propositions in their concept maps. However, retrieval-based concept mapping leads to fewer concept map-quality. The results underline the effectiveness of concept mapping as a retrieval practice. Beyond, our study enables direct recommendations for the use of concept maps in biology class.

The effects of a peer tutorial with an integrated learning strategy training on the biology students' use of learning strategies in university

Matthias Wilde and Svea Kleinert

First-year biology students face various challenges in the introductory phase. Due to these challenges in the transition from school to university, self-regulated learning and the use of learning strategies play a significant role for first-year biology students. Therefore, learning strategy trainings are increasingly implemented in the university learning context. The current study examines the influence of a peer tutorial with an integrated learning strategy training on the biology students' use of learning strategies. 191 first-year biology students (Mage=20.49±3.10; 64,4% female) participated in a peer tutorial accompanying an introductory biology lecture. While additional learning strategy training was implemented in the tutorial for the biology students in the experimental group (n=100), the biology students in the control group did not receive any additional teaching of learning strategies (n=91). Data about the use of learning strategies were collected in the pre and post test. The ANOVAs with repeated measures revealed significant effects of time with regard to cognitive, metacognitive, resource-based learning strategies. In addition, the ANOVAs with repeated measures indicated significant time x group interaction effects. The first-year biology students' in the experimental group reported higher increased of the use of rehearsal, organisational, planning, monitoring, and time management strategies. The results showed that learning strategy trainings could promote the use of relevant learning strategy trainings for studying biology. For this reason, these peer tutorials could provide an effective support for first-year biology students in the introductory phase.

Validation of a scoring rubric to measure pre-service biology teachers' lesson plan quality

Leroy Großmann and Dirk Krüger

Lesson planning is a core part of professional teachers' expertise. When engaging in lesson planning, pre-service biology teachers (PBTs) need pedagogical content knowledge (PCK) to plan efficient learning environments that help particular students to learn biology. Particularly in teacher training programs (e.g. in Germany) PBTs are expected to write lesson plans describing and justifying their instructional decisions. Recent studies have shown that PBTs have difficulties to interconnect different PCK aspects in plan lessons that help particular students to achieve the intended learning outcome. In order to help PBTs to do so, a scoring rubric was developed that aims to emphasize the need to interconnect PCK aspects such as instructional strategies and students' understanding in science. The rubric consists of 24 criteria each describing three performance levels (limited, basic, exemplary). To test for the scoring rubric's quality, evidence for validity was collected. In particular, teacher educators (N = 10) rated the relevance of the criteria and PBTs rated whether the rubric was comprehensible to them. Moreover, the scores in the rubric were compared to the grades that PBTs received in the final examination after 6.5 years German teacher training to test for predictive validity. Results indicate that the criteria are objective since reliability values are substantial to excellent. Furthermore, the criteria are regarded relevant by teacher educators and there is evidence for predictive validity which supports the idea that the rubric is useful for the analysis of lesson plans to provide information about the quality of teaching in the lesson.

17:30-18:30	Research Café* & More**
Location:	Building: XΩΔ01, Room: 103
	*An open space where an individual or group of researchers can present projects or relevant information for the ERIDOB community. Please let the Local Committee know in advance if you wish to present something.
	**More rooms will be available to use if you wish to discuss any other subject.

20:00	ECR Party-Social Event
Location:	The Old Power House

Time	Wednesday, August 31st
09:00-10:30	Parallel Session 3
	Paper Session 3A - Outdoor and Environmental Education
Location:	Building: XΩΔ01, Room: 108
Chair:	Marcus Hammann

I want to engage my pupils in climate change, but...

Mikael Rydin, Niklas Gericke, Jesper Haglund and Nina Christenson

Climate change is an important, yet challenging topic to teach. Challenges include having the knowledge of complex process, being able to address controversial aspects of politics and emotions. Research have shown that pre-service teachers are willing, yet hesitant to teach climate change. In addition, research have shown in-service teachers avoid the topic, despite believing climate change to be an important issue. Preparing pre-service teachers to teach climate change is a crucial part in combating such issues. This study aims to investigate pre-service teachers' beliefs about teaching climate change. Six Swedish pre-service teachers participated in depth semi-structured interviews including a reflective exercise on teaching climate change. Data was analyzed using a thematic analysis. Results reveal three dilemmas pre-service teachers face in regard to teaching climate change: the dilemma of being a neutral teacher, the dilemma of knowledge progression, and the dilemma of aligning the purpose with the content in teaching climate change. These results have implications for teacher education and provide insight for both pre-service teachers and in-service teachers.

Personal relevance in high school students' nature experiences: Findings from the draw-and-write method

Marcus Hammann

As children become increasingly alienated from nature, biology educators need to create opportunities for personally relevant nature experiences. Using the draw-and write-method, we asked high school students' (n=70; aged 10-18 years) to portray a particularly memorable nature experience and rate its perceived personal relevance. Perception of personal relevance was associated with gender, age, inner aspects (explicit positive evaluations) and outer aspects (type of setting and social context) of the nature experience. Female students and younger students rated their nature experiences more personally relevant than male students and older students. Furthermore, high school students rated their nature experiences more personally relevant in human-made settings than in natural settings, and when it occurred with a friend or with family members rather than when it occurred alone, in class/kindergarten or in an unspecified group. Explicit descriptions of the beauty of nature and positive evaluations of the nature experience predicted the students' perception of personal relevance. Most students attached considerable importance to personal experiences with nature and advocated opportunities for nature experiences in biology instruction. We discuss these findings in terms of how biology educators can create opportunities for students to promote personally relevant nature experiences

Action Competence for Insect Preservation (ACIP) – A new framework and quantitative scale to take action for insects

Peter Lampert, Daniel Olsson and Niklas Gericke

The decline of pollinators and other insects is a worldwide environmental issue with potential negative effects on ecosystems and our daily lives. Therefore, halting insect decline is a key aim of several international policies. Despite a growing awareness of the problem, the rates of decline are still growing, which indicates an implementation gap in many areas. Therefore, our educational design research project focuses on "Action Competence for Insect Preservation (ACIP)" to close citizens' implementation gap. The project shall improve the theoretical understanding of citizens' ACIP. This is achieved by developing the new ACIP-framework and a corresponding quantitative research instrument to measure citizens' competences in this field. The ACIP-framework provides educators with a scientifically grounded frame for teaching about the topic of insect conservation in an action-oriented way. The two main categories of the framework are direct actions and indirect actions, which both

contribute to mitigate insect declines. The new research scale enables the assessment of individuals self-perceived action competences and shows a broad spectrum of potential applications in educational contexts. At the ERIDOB conference, we will present details of the development and validation of the ACIP-framework and the quantitative scale. We will also outline how we use educational design research to connect these two components with the design of teaching interventions. Finally, we will discuss how the framework and the research instrument can help to overcome implementation gaps in insect preservation and contribute to achieve global diversity and sustainability goals.

An Action Research Approach for the development of children's environmental motivation through their participation in a schoolgarden project: Reflections and Revisions

Anthi Christodoulou and Konstantinos Korfiatis

This paper reports data from the action research cycles of an Environmental Educational programme with the ultimate goal of developing students' environmental motivation. Primary school students participated in a school kitchen-garden project. The activities were based on students' thoughts and decisions during the implementation of the project. Students had the most active role, while the teacher/researcher and the colleague-teachers functioned as collaborators and facilitators of them. The project included weekly routines concerning the cultivation of plants, as well as seventeen 40-minute meetings between participants, their teacher and the researcher. The goal was to identify the ideal activities and teachers' strategies that seem to positively affect participating children's environmental motivations. The research team included the teacher/researcher, the critical friend and the facilitators which were the school's Principle and three "colleagues-teachers" (two of them were teaching during the morning school lessons and one during the after-school program). Meetings between the research team were held regularly during the cycles of the action research process. Data were derived from T/R notes during the project. The results exhibited four cycles action research and eleven themes raised during the reflection processes of these action research cycles. The research team played a vital role in the development and continued adaptation of the project in order to meet children needs.

Time	Wednesday, August 31st
09:00-10:30	Parallel Session 3
	Paper Session 3B - Scientific Thinking, Nature of Science and Argumentation
Location:	Building: XΩΔ01, Room: 103
Chair:	Dina Tsybulsky

Pre-service biology teachers' socioscientific decision-making: Analyzing structural and content complexity in the context of a mandatory Covid-19 vaccination

Nina Minkley, Carola Garrecht and Moritz Krell

To foster students' socioscientific decision-making (as a major goal of biology education), pre-service biology teachers (PBTs) themselves need to develop this competence. However, only a few studies thus far investigated PBTs' decision-making and none of these studies compared different coding schemes that can be used for analysis. Therefore, we applied different schemes to examine the structural and the content complexity of PBTs' decision-making in the context of a mandatory Covid-19 vaccination. In total, 76 PBTs from a German university participated. Via an online survey, each PBT was asked to decide whether mandatory vaccination against Covid-19 should be introduced. The written answers (i.e., decisions) were qualitatively analyzed regarding their structural (using three existing coding schemes) and content (using one existing coding scheme) complexity. Most participants achieved rather low levels of structural complexity, indicating they rather seldom included pros and cons and gave detailed reasons in their decisions. Nevertheless, differences have been found in the data depending on the applied coding scheme. Regarding the content complexity, participants reported 2.5 arguments on average. Nearly 2/3 of the arguments were provided against and 1/3 for a mandatory vaccination. The content areas which were referred to most often included science, society, and ethics, regardless of whether they argued for or against mandatory vaccination. The relationship between the structural and the content complexity is currently being analyzed and will be presented together with implications for biology teacher education at the ERIDOB conference.

Enlightening Our Visitors: Natural History Museum Educators' Conceptualize the Integration of NOS When Addressing Ecological and Evolutionary Aspects of Exhibits

Anna Pshenichny-Mamo and Dina Tsybulsky

A major goal of natural history museums (NHMs) is to shape visitors' worldviews about the process of scientific research, by allowing them to learn about the process, its characteristics, and the people behind it. In this context, developing visitors' understanding of the nature of science (NOS) is an underlying educational objective. Museum educators (MEs) mediate between the museum visitors and the exhibits. They design and determine how to display the exhibits' contents. To date, little is known about NHM educators' conceptions, the way they address – if at all – NOS aspects when guiding museum visitors through the exhibits. Hence, the following research question was posed: How do MEs conceptualize the integration of various aspects of NOS when addressing ecological and evolutionary issues while guiding visitors through the exhibits? The research participants were MEs (N = 15) in four NHMs in Israel. The study used a qualitative approach. Data were gathered using semistructured interviews, which were recorded, transcribed, and analyzed using the content analysis method. The study's findings revealed three major categories of MEs' conceptions of integrating NOS aspects when guiding visitors through the exhibits: a) in the context of describing general scientific research, b) in the context of research conducted at the museum, c) in the context of museum exhibits. MEs' conceptions indicate that they use an implicit pedagogical approach of NOS integration throughout guidance in NHMs.

The Role of Biological Content-Knowledge for Abductive Reasoning in Modeling

Paul Engelschalt, Dirk Krüger and Annette Upmeyer zu Belzen

Modeling is essential in scientific inquiry and consists of model construction and model application. Abductive reasoning as a crucial step in model construction is the process of finding and selecting causes to plausibly explain a phenomenon by utilizing prior knowledge and creativity. Thus, abductively thought-up causes are understood as models for explaining phenomena. In this study, the role of biological content-knowledge in abductive reasoning processes during model construction was examined by instructing 128 pre-service Biology teachers to map their personal process solving a biological phenomenon in a diagram. Afterwards, the participants reported the number of causes they found. Furthermore, by answering rating-scale items, they judged on whether at least one among their found causes was plausible and to what extent their biological content-knowledge helped them finding causes. A significant correlation was found between the number of formulated causes and the judgment of whether at least one plausible cause was found ($r = .45$, $p < .001$). Furthermore, a correlation between self-reported engagement with biological content-knowledge and the judgment of whether at least one plausible cause was found is reported ($r = .43$, $p < .001$). These results emphasize that biological content-knowledge fosters finding multiple and plausible causes in biological model construction. The continuation of the study by analyzing the generated diagrams by two independent raters will provide further inferences on how perceived content-knowledge led to multiple and plausible causes in model construction and, in addition, how perceived content-knowledge is related to engagement in model application.

Effects of (non-)restrictive learning opportunities on the development of research competence in biology education

Lea Gussen, Fabian Schumacher, Laura Ferreira González, Kirsten Schlüter and Jörg Großschedl

Research competence enables teachers to understand and interpret research findings in order to reflect on their own teaching activities. It comprises affective-motivational (e.g., finding joy in conducting research) and cognitive abilities (e.g., research skills). Inquiry-based learning is an established method to foster research competence in teacher education. According to the self-determination theory, the degree of autonomy determines the outcome of inquiry-based learning activities. It is unclear to what extent the structuring vs. openness of individual learning paths (restriction / autonomy) affects the development of research competence. We conducted an experimental intervention study and compared groups with low and high degrees of autonomy. Both groups developed, performed, and analyzed a research project in biology education. A series of online learning units provided information about research methods. Whereas the treatment group could not proceed to the following online unit before completing the previous unit (restrictive group), the control group was free to choose their learning path (non-restrictive group). At the beginning of the semester, $N = 199$ pre-service teachers were randomly assigned to the treatment and the control group. Research competence was measured in a pre-posttest design. Results show that in both groups, affective-motivational abilities decreased and cognitive abilities increased from the beginning to the end of the semester. The treatment group outperformed the control group in a performance test in terms of research methodology knowledge. Thus, restriction might positively influence learning, although autonomy is restricted.

Time	Wednesday, August 31st
09:00-10:30	Parallel Session 3
	Paper Session 3C - Teaching Strategies and Learning Environments
Location:	Building: XΩΔ01, Room: 109
Chair:	Christina Ottander

Promoting digitally supported experimentation in heterogeneous classes through teacher training

Patrizia Weidenhiller, Susanne Miesera and Claudia Nerdel

Digital transformation and inclusion are key issues for school development and teachers' professional development. This study combines both topics in teacher training, which focusses inquiry learning in classrooms. The aim of the study is to analyse the increase of teachers' professional knowledge according to the TPACK model. Therefore, teachers plan and perform a digitally supported experiment and train to differentiate it. Furthermore, the study aims at identifying predictors for the support of the knowledge acquisition process of all students in science education by using digital media and thus to meet the learners' needs in heterogeneous classes. The pre-post comparison shows a significant increase of teachers' professional knowledge according to the TPACK model and specifically of the application of digital media when using experimental procedures in heterogeneous classrooms. These results indicate an effective intervention with regard to professional knowledge, which can favour the use of digital media in teaching in general and specifically for inquiry learning in heterogeneous classes. In summary, the study shows how teachers can be effectively prepared for experimenting with digital media in heterogeneous groups through practical training.

The influence of International collaboration on open inquiry-based teaching - A case study

Pirchia Tamar Waxman, Christine Girtain, Dana Sachyani, Galit Karadi, Irit Sadeh, Shoshana Herman, Mor Farber Levi, Michal Yaacobi, Omer Choshesh, Efrat Link, Samuel Ginsburgand and Michal Zion

Inquiry-based learning and especially open inquiry promotes science teaching and understanding the nature of science. However, conducting open inquiry projects with students at school raises many difficulties such as the need to change their way of teaching and study new topics that are not part of the curriculum. It turns out that collaboration and motivation can give crucial support for the creation of a learning community of teachers and students during the challenges of the open inquiry process. The purpose of this study is to examine how international collaboration between teachers and students from different countries influence the expression of dynamic inquiry performances, collaboration and motivation during an open inquiry learning process. The learning process is part of a unique teaching method in Israel called Bio-Inquiry on the Web (BIW), in which students from different classes work together. Students and teachers from Israel and New Jersey participated in this study. The collaborative inquiry project is called The Global STEM Wolbachia Project. Students investigated the prevalence of a bacterium called Wolbachia in mosquitoes collected in Israel and New Jersey, USA. using molecular biology methods. Teachers and students participated in an online questionnaire that was analyzed qualitatively. The results indicate that this program facilitates the promotion of inquiry performances, collaboration, motivation. By doing something new, using advanced research technologies, and working with students from another country, both teachers and students were motivated to improve the open inquiry process.

Using educational technologies to characterize students' explanation types as means to promote personalized teaching and learning

Moriah Ariely, Tanya Nazaretsky and Giora Alexandron

Constructing scientific explanations is one of the core practices in science. However, many students are unable to construct proper explanations, and they often fail to discern explanation from description, or misunderstand the causes that are relevant to the explanation of the

phenomena. Revising written explanations is important for supporting students in constructing scientific explanations, and personalized instruction can significantly enhance learning outcomes. Educational technologies that are designed to support teachers in providing personalized instruction can enhance their ability to address the needs of individual students. Here we present an analysis of students' written explanations about the effect of anemia and smoking on physical exercise. We used analytic grading rubrics and cluster analysis to reveal students' response patterns that were found based on these rubrics. This step can be used to automatically classify new graded explanations into different patterns. Based on these patterns, we categorized students' explanations into four types, ranging from full explanations that include all or most of the conceptual components and causal relations, to different degrees of partial explanations that lack causal relations, conceptual components, or both. Our findings serve as proof of concept that automated tools that are based on high quality grading rubrics, can elicit patterns that are both pedagogically meaningful and stable, and that can be used to automatically classify students' responses. Using such tools, teachers can gain insights about how to generate and evaluate scientific explanations, and provide their students a personalized feedback or treatment that will address specific gaps in the explanation.

Digital science competence: Secondary school students' reasoning about filter bubbles and search engines

Anna Lodén, Johanna Lönngren and Christina Ottander

Secondary school education needs to develop students' digital competence in all school subjects, including biology education. However, in countries such as Sweden, digital competence is only included in social science subjects. There is also a lack of research on digital competence teaching and learning in science education. This study begins to address this gap by exploring students' reasoning about digital information retrieval in biology education. The research question is: How do secondary school students' reason about filter bubbles and their use of search engines when searching for scientific knowledge online? The study employs mixed methods, including (1) a questionnaire with open-ended and multiple-choice questions, (2) written reflections and (3) focus group discussions. Altogether, 68 students participated. Ribble's framework for digital citizenship was used to design data collection and in abductive thematic data analysis. The preliminary findings highlight the importance of students' knowledge and understanding of science concepts for retrieving credible and precise search results, and a need to develop students' awareness of, and critical reflection about, how filter bubbles can influence search results and the consequences this may have for social life. The study thus supports the need for developing digital competence in science education. However, more research is needed to explore how this could be done in practice. How can science teachers help students develop the skills and attitudes they need to engage critically and constructively with the ever-increasing amount of science-related information online?

10:30-11:00	Coffee Break
Location:	1 st floor balcony

Time	Wednesday, August 31st
11:00-12:30	Parallel Session 4
	Paper Session 4A - Students' Conceptions & Conceptual Change Symposium 1: Evolution education research across the educational stages: Obstacles and opportunities for teaching and learning evolution
Location:	Building: XΩΔ01, Room: 108
Chair:	Daniela Fiedler

What about the children? Developing an instrument to measure knowledge about evolution in kindergarten

Isabell K. Adler, Daniela Fiedler and Ute Harms

The theory of evolution is the core theory of the life sciences and is taught in schools and universities of most European countries. However, researchers postulate that introducing the topic earlier in the curriculum might help initiate knowledge about evolution and facilitate subsequent learning. A growing number of interventions aim at promoting children's understanding of evolution, although there are no consistent procedures for evaluating the effectiveness of such interventions. Indeed, most studies within early education rely on unvalidated interviews. We aim to change this by developing a standardized interview to measure knowledge about evolution in children aged five to six years. The instrument includes 40 items addressing the evolutionary principles of variation, inheritance, and selection, which can be used with animal or plant examples. Children's responses are evaluated based on a category system that defines different levels of conceptual knowledge. Currently, the instrument and category system are piloted in several rounds with children aged five to six years. The main survey will be conducted with 20 children of this age group. The final instrument and results of this study will be presented at ERIDOB conference.

Comparing elementary school students' predictions and explanations of evolutionary processes- an exploratory study within the EuroScitizen network

Lucía Vázquez Ben, Patrícia Pessoa, Neil J. Gostling, Nausica Kapsala, Alexandra Moormann, Giulia Realdon, Mónica Arias, Alessandra Beccaceci, Livia Bianchet, Giulia Bombi, Moraima Castro-Faix, Margarida M. Marques, María del Carmen Souto García and Xana Sá-Pinto

Although several researchers and countries' curricula highlight the need to introduce evolution since elementary school years, few studies have analysed what and how can students at these ages learn about evolutionary processes. The studies available suggest that elementary school students can learn about evolution by natural selection through multiple strategies but show strong differences in the frequency of teleological explanations they provide. However, the assessment instruments used in these studies differed in many aspects including the type of students' tasks, biological scenarios presented and structure of the assessment instruments. This precludes clear understanding of the causes for the observed differences. We aim to study how the type of tasks and biological scenarios presented affect the frequency of teleological explanations provided by students of distinct ages and their ability to apply key concepts to explain and predict evolutionary processes. For that, we adapted previously published assessment instruments and we built four distinct questionnaires that differ in these two aspects. These questionnaires were made available in six languages (English, German, Greek, Italian, Portuguese, and Spanish). The questionnaires will be distributed to students of 3rd (8-9 years) and 5th grade (10-11 years) from six countries, and the results will be compared in terms of teleological explanations provided and key concepts applied by the students. Our work will result in assessment instruments that can be used by elementary school teachers and researchers, and knowledge to inform curriculum design.

Is this about me? Understanding the impact of anthropocentrism on undergraduate learning about antibiotic resistance

Catie Nielson and John D. Coley

Biology instructors frequently employ human examples to explain concepts and engage their students. However, this can have a dual effect; anthropocentric thinking—centering one’s understanding of the natural world on humans—has been related to both conceptual misunderstandings and facilitated learning. We sought to understand how anthropocentric thinking impacts biology learning—in particular, learning about evolution through antibiotic resistance. In the present study, undergraduate students were randomly assigned to read an instructional text about antibiotic resistance either with or without anthropocentric language. We assessed student language and misconceptions through an open-ended prompt and agreement with a misconception statement. Students were more likely to use human examples after reading the anthropocentrically framed article compared to the control article and students who referred to humans in their explanations were more likely to agree with an anthropocentric misconception. This work demonstrates potential drawbacks to using human examples to teach an evolutionary case.

Diagnosing evolutionary explanations: Effects of a chatbot support system on teacher students’ diagnostic competence

Daniela Fiedler, Daniel Schönle, Christoph Reich and Ute Harms

Teaching the processes of evolution requires diagnostic competence of the teacher (i.e., the ability to assess students understanding accurately). During biology teacher preparation at university, however, respective learning opportunities are rare. Digital technologies like the classroom simulation SCRBio offer new ways to address this gap. The SCRBio provides real-like classroom situations in which teacher students are prompted to perform formative (i.e., evaluate virtual students’ evolutionary explanations) and summative assessment (i.e., assess virtual students’ overall performance). To support teacher students in the SCRBio to develop diagnostic competence for evolution, a chatbot is integrated that interacts with the user by answering queries and giving feedback automatically without human intervention. In our study, we investigate to what extent this chatbot support system (SCRBio combined with a chatbot) can influence teacher students’ development of diagnostic competence relating to evolution. A total of 60 biology teacher students will participate during data collection in February and March 2022. The findings will be presented and discussed.

Time	Wednesday, August 31st
11:00-12:30	Parallel Session 4
	Paper Session 4B - Students' Values, Attitudes and Decision Making
Location:	Building: XΩΔ01, Room: 109
Chair:	Anna Beniermann

Aquaculture - how pre-service teachers' perception interacts with environmental values, system knowledge and conceptions of environmental concern for decision

Michaela Maurer, Verena Pietzner and Corinna Hößle

The responsible use of resources is an essential goal of Agenda 2030. An overall need of 180 tons of fish per year is pushing the limits of natural fishing. Overall, teachers have the possibility to focus on this topic to enhance the environmental awareness consciousness of learners for sustainable issues (e.g. sustainable consumption, production and to support sustainable judgements). 158 pre-service teachers across different subject profiles (M=24.75, SD±4.45, female=46.24%) from a German University illustrate the extent to which aquaculture contributes from knowledge to action by participating in our online test for assessment voluntarily. We used five open questions relating the term of aquaculture, a semantic differential of 14 adjective pairs for interest and usefulness of aquaculture, the EMS-Scales (Schultz, 2001) for environmental values and a self-developed item set of system knowledge, consumer behaviour and social influences. The results show that terms relating to aquaculture can be defined mostly correct, but an overall understanding of system knowledge, for example, is missing. Aquaculture seems to be associated with profit, but less with nutritional aspects or environmental concerns. Results of biology pre-service teachers do not significantly differ from other subjects. This study illustrates a possible barrier to transforming fewer familiar issues into society.

Attitudes towards Controversial Science Issues and their justifications in pre-service biology teachers

Anna Beniermann, Sascha Kurz and Annette Upmeier zu Belzen

Argumentation skills are a central goal in science education and a foundation for evidence-based decisions on scientific topics with high individual and social relevance. Such topics are referred to as Socioscientific Issues in educational settings or as Controversial Science Issues (CSI) when there is controversy even though a scientific consensus exists. Individual attitudes towards CSI affecting argumentation skills have shown to be dependent on affective factors. To date, only a few studies have investigated the content of arguments or justifications on CSI. In the present study, we aim to investigate, how cognitive and affective factors are associated with attitudes towards CSI and how negative attitudes towards different CSI are justified. In a survey of 89 pre-service biology teachers, we investigated attitudes towards evolution, climate change, genetically modified food, and vaccination, their justifications as well as cognitive and affective factors via questionnaire. Attitudes on CSI differed concerning their relation to other variables. Trust in science correlated positively with attitudes towards evolution, climate change, and vaccination. Attitudes towards evolution and vaccination were positively related to knowledge about NOS. Attitudes towards vaccinations and genetically modified food were negatively related to conspiracy ideation. Justifications of negative attitudes about genetically modified food demonstrated naturalistic fallacies and personal lack of knowledge, while negative attitudes on vaccinations referred to a lack of sufficient evidence for their safety. Results suggest that attitudes towards CSI are context-dependent. Affective factors like trust in science and the opposition to conspiracy ideation might foster positive attitudes about CSI.

Do Biology Textbooks Help Teachers in Dealing with Socio-scientific Issues? - A Content Analysis of German Biology Textbooks

René Leubecher, Alexander Bergmann, Maja Funke and Jörg Zabel

In German biology classes Socio-scientific Issues (SSIs) are used to foster Bewertungskompetenz (BK) of students. BK holds similarities to decision-making. Biology teachers struggle with both addressing SSIs and fostering decision-making in biology classrooms. Teachers claim a lack of material regarding SSIs, which is astonishing, since biology textbooks should offer assistance via tasks asking students to engage in SSIs and hence foster their decision-making competence. Due to this discrepancy, we conducted an integrative content analysis of German biology textbooks using an established model of BK sub-competences to identify the quantity and quality of tasks dealing with SSIs. We were also interested if the model of BK is adequate for such an analysis. We found (i) a limited proportion of tasks fostering BK (8,5% of the entire sample), (ii) about a third (29,2%) of the tasks fostering BK not operationalized clearly and (iii) tasks focus on argumentation, but scarcely address other sub-competences. Our findings indicate that the quantity of tasks fostering decision-making is low. Their quality should be improved substantially. The model of BK provides an adequate basis to analyze biology textbooks regarding SSIs, but needs revision to gain more detailed granulation.

Factors that influence elementary school students' attitudes towards intraspecific biodiversity

Patrícia Pessoa, Sara Aboim, Lisa Afonso, J. Bernardino Lopes and Xana Sá-Pinto

Biodiversity conservation has been set by the United Nations as one of the 17 sustainable development goals. Intraspecific diversity is fundamental for decreasing the probability of species' extinction and attitudes and behaviors that lead to intraspecific biodiversity conservation are thus important. To foster behavioral change, it is necessary to know the factors that may influence those to inform the development of future educational activities. No study has identified what factors influencing elementary school students' attitudes towards intraspecific biodiversity conservation and there is no available framework to perform such analysis. Given this, in this study we aimed to analyse the factors that influence elementary school students' attitudes. For that we developed a framework of analysis based on previous studies on public attitudes towards biodiversity. We applied it to elementary school students' that engaged in an activity developed to foster positive attitudes and behaviors towards intraspecific biodiversity, and improved it based on students' answers. To further ensure its validity we applied it to a control group. The current version of the framework includes categories related with internal factors (emotional, aesthetic, and knowledge) and with external factors (economic, social, cultural and ethical). The subcategory most found in the students' answers was 'emotional'. The subcategory 'knowledge' had a large increase from pre to post tests in the target group. This study needs to be extended to a larger sample of students and future studies are needed to assess correlations between factors.

Time	Wednesday, August 31st
11:00-12:30	Parallel Session 4
	Paper Session 4C - Outdoor & Environmental Education Symposium 2: Environmental Literacy – Appropriate Umbrella for Educational Initiatives
Location:	Building: XΩΔ01, Room: 103
Chair:	Bogner F.X.

Environmental Attitude's Pivotal Role for Learning

Baierl, T., Kaiser F. X., and Bogner F.X.

People's commitment to environmental preservation—their environmental attitude—appears critical for manifest engagement. Correspondingly, it seems advisable that environmental scientists, educators, and policy-makers also pay heed to environmental attitude's role in learning, another form of manifest behavior. In our research, we tested the hypothesis that people with stronger environmental attitudes learn comparatively more about environmental issues than people with weaker such attitudes. In a sample of 1,896 students ($M = 14.2$, $SD = 1.8$), we identified people's environmental attitudes in their verbal expressions of support for preserving the environment and their self-reports of past behavior aimed at preserving the environment. We corroborated our hypothesis and found people's preexisting environmental attitudes to play a decisive role for acquiring new knowledge. We also corroborated the characteristic developmental trajectory of adolescents' environmental attitudes with an early maximum at around age 11 or 12, a minimum at around age 16, and a subsequent recovery.

Informal Earth Education: Significant Shifts for Environmental Attitude and Knowledge

Baierl, T., Johnson, B. and Bogner F.X.

Environmental education aims to affect environmental knowledge and attitude to ultimately induce pro-environmental behavior. Based on 247 upper elementary school students, we tested the impact of an outdoor-based earth education program on environmental knowledge and attitude with a prepost design. Both outcome measures were Rasch scales. Environmental knowledge is a composite of 27 system, action, and effectiveness knowledge items, and environmental attitude is a composite of 13 evaluative statements and 11 self-reported behaviors about nature preservation. Our analysis revealed gains in environmental knowledge and attitude. The convergence between knowledge and attitude increased significantly from pre- to post-program, and attitude played a significant role in knowledge acquisition.

The Impact of Environmental and Sustainability Education on Environmental Literacy of Secondary School Students

Cincera, J., Kroufek, R. and Bogner, F.

The presentation introduces the results of the first national survey of the environmental literacy of the secondary school students in the Czech Republic. Specifically, it focuses on the following research questions: a) what is the relationship of selected components of environmental literacy and, particularly, their responsible environmental behavior, b) what is the impact of selected ESE-teaching strategies on the environmental literacy of students, and c) what is the level of environmental literacy of the Czech secondary school students. To obtain relevant data, a stratified sample of 641 Czech schools was selected. In each of the schools, one class of 8th-grade students ($M_{age}=13.4$ years) was involved. In total, data from the representative sample of $N=21518$ students were collected. The survey investigated students' environmental values (Bogner, 2018), knowledge, place attachment, climate change attitudes, locus of control (Powell et al., 2011), and environmental behavior. In addition, the survey focused on students' perceived ESE-strategies (Olsson, Gericke & Chang Rundgren, 2015). Students were asked to indicate if they perceived their ESE as participative and pluralistic, holistic, and connected with their community. They also indicated if they participated in a residential outdoor environmental education program in the last two years

and if they are members of an environmentally-focused team or club in their school. The findings supported a crucial role of locus of control and environmental attitudes (preservation of nature and appreciation of nature) on pro-environmental behavior, while the role of other variables remained limited, or moderated by respondents' locus of control. The respondents who participated in a residential environmental education program, or who were members of a school environmentally-focused clubs, had a higher level of proenvironmental behavior, attitudes, and the most of other investigated variables. Perceived participative and community-based approach in ESE were correlated with students' locus of control, the perceived holistic approach with their climate change attitudes.

12:30-13:45	Lunch
Location:	Restaurant A.Zorbas
13:45-15:30	General Assembly / Business Meeting
Location:	Building: XΩΔ02, Room: B205
16:00	Tours-Social programme

Time	Thursday, September 1st
09:00-10:30	Parallel Paper Session 5
	Paper Session 5A - Outdoor and Environmental Education
Location:	Building: XΩΔ01, Room: 103
Chair:	Annette Scheersoi

The impact of animal encounters on zoo visitors' interest in conservation

Jana Schilbert and Annette Scheersoi

With more than 40,000 threatened species, biodiversity is under human pressure. Against this background, conservation plays an important role to counter this situation. Many institutions, such as zoos, seek to fight biodiversity loss through education. Zoos provide nature experiences in the form of animal encounters and follow the aim to motivate visitors' pro-environmental behaviours and attitudes through education. This study seeks to investigate to which extent animal encounters foster visitors' interest in conservation.

Initially, interest in conservation was explored from both the visitors' and zoo professionals' perspectives through conducting interviews with visitor groups (n=16) after their visit and zoo professionals (n=4) about their conceptualisation of conservation and opportunities of conservation learning in the zoo. We also used visitor observations (n=12) and visitor interviews after an animal encounter (n=17) to explore the role of conservation in animal encounters. Data was analysed through qualitative content analysis. Differences in conservation understandings between zoo professionals and visitors were detected. It also became clear that visitors retrieve conservation information exclusively from signage, although zoo professionals name much more opportunities for conservation learning. During direct animal encounters, the theme of conservation seems to be of minor importance.

On the basis of this data, specific aspects of conservation that foster the visitors' interest (e.g., environmental threats) are now explored and hypotheses about how zoo learning environments should best be designed to foster conservation education at the zoo are derived. Such design-hypotheses will be presented and discussed at the conference.

"Environmental citizens in Action": A novel learning intervention grounded on the Education for Environmental Citizenship pedagogical approach

Andreas Ch. Hadjichambis, Demetra Hadjichambi and Yiannis Georgiou

Education for Environmental Citizenship (EEC) is of critical significance for the development of secondary education students' pro-environmentalism. However, little is yet known on how Environmental Citizenship (EC) can pedagogically be approached, while empirical documented interventions are also limited. This paper presents a case study which evaluates a novel learning intervention grounded on the EEC pedagogical approach. The participants were fifty students in secondary Biology education and data were collected with the Environmental Citizenship Questionnaire (ECQ) before and after the intervention. Our findings provided empirical documentation supporting the contribution of the learning intervention to the development of students' EC. Importantly, our findings indicated that the impact of the learning intervention was significantly related to students' gender and their past/present EC actions.

Measuring psychological distance towards climate change: A new multidimensional scale and its correlates

Alexander Büssing

As the climate crisis is still ongoing, teachers represent a key for the appropriate education of future generations. In prior studies, climate change has been described as an abstract phenomenon, which is why a perceived distance to the issue may be one reason for a lack of teaching motivation. One way to operationalize the distance towards issues such as climate change is the psychological distance, which describes the subjective closeness towards objects regarding their perceived geographical, temporal, social, and hypothetical distance.

The present study applied a new multidimensional measurement scale for measuring in-service teachers' psychological distance towards climate change and investigated its measurement abilities (RQ1) and correlates (RQ2). A confirmatory factor analysis and measures of internal consistency were used to evaluate the measurement, attitudes towards climate change were predictors of and predicted by different dimensions of psychological distance. The social distance and attitudes were predictive for the enjoyment for teaching about the issue, which is why these factors may be relevant for teaching motivation. While further studies are needed to further evaluate and validate the measurement abilities of the instrument, the application of psychological distance for biological topics such as climate change in teacher education will be discussed on the conference. As a most important step, the construct may be discussed as correlate of other relevant variables of teachers' competencies such as pedagogical content knowledge (PCK) or in-class behaviors outlined in existing models of teacher professional development.

Gaining Insights into Biologists' Work Locations and Scientific Activities

Bianca Reinisch, Daniela Mahler, Jasmin Opitz, Moritz Krell and Tom Bielik

Many students possess a stereotypical conception of a scientist wearing a lab coat while doing experiments in a laboratory. While there is consensus that this conception is rather inadequate (i.e., not authentic), it remains unclear, what can be counted as an adequate view. This study aims to provide an authentic insight into biologists' scientific activities and their work locations. The results will serve as a baseline for future studies, in which students' conceptions about scientific work will be evaluated, for example, by the Draw-A-Scientist-Test. 94 biologists with various backgrounds (e.g., doctoral student, postdoc, professor) and research areas answered an online questionnaire. Among others, the biologists were asked to describe three of their scientific activities and the corresponding work locations in detail. Based on existing categories in the research literature, we developed a category system which includes eight activities (thinking, teaching, realistic, publishing and reviewing, enterprising, conventional, networking, learning) and 14 locations, which were subsumed under three main locations (in the research institute; in the field; others, e.g., at home). This variety of activities and locations seems to be much broader compared to the stereotypical conception students possess about scientific work. The results will provide the basis for a coding scheme for a follow-up study in which students' conceptions about biologists and their work will be assessed using a digital tool.

Time	Thursday, September 1st
09:00-10:30	Paper Session 5B - Scientific Thinking, Nature of Science and Argumentation
Location:	Building: XΩΔ01, Room: 108
Chair:	Marcus Grace

Arguments from Vaccine Hesitancy about COVID-19 in Spain: Epistemic disagreements

Maria Pilar Jimenez Aleixandre

In the current context of pandemics, associated with a rise in post-truth and fake news, argumentation and critical thinking skills and practices are necessary for all citizens. The WHO (2019) identified Vaccine Hesitancy (VH), as one of the top ten threats to global health. Using data from a Spanish survey (ISCIII, 2021) among people refusing COVID-19 vaccine, we examine their arguments for not getting it. The research questions are: 1) Which misunderstandings about science methods and processes are revealed in VH arguments? Which criteria are used to identify sources of information? 2) Which common themes are found in the arguments of Anti-vaccines movements (AVx) and the arguments of vaccine hesitancy? We draw a distinction between AVx, who actively oppose vaccination and spread fake news, and VH who refuse vaccination. Arguments are examined drawing from Plantin (2019), for emotive tension, and from Barzilai and Chinn (2020) for addressing post-truth. Findings: Compared with literature about VH prior the COVID-19 pandemics (de Figueiredo et al., 2020), and besides issues of safety and efficiency, a new argument emerges with the higher frequency (72%): that vaccines have been developed too fast. We interpret it as epistemic disagreements: a lack of understanding of the methods and processes for producing and applying scientific knowledge, or not knowing how to know, as well as lack of criteria about reliable sources of information. Educational and communicative implications are discussed.

Questioning Mandatory Vaccination: A Way To Grasp The Concept Of Herd Immunity?

Olivier Morin and David Favre

In this communication, we'll consider the way tackling Socially Acute Questions (SAQs) might be an opportunity to deepen comprehension of scientific concepts for people embracing such tough questions. Regarding didactic of biology, we'll focus on the question: to what extent does the questioning of mandatory vaccination lead people to reason about the validity limits and contexts of applications of herd immunity concept?

Since herd immunity stems from the effects of individual immunity scaled to the level of the population, this integrative concept deals with scientific and social dimensions. We seek both of them in the responses of 250 French educators from diverse fields, such as biology teachers or activity leaders of health associations, who were questioned during professional training sessions conducted since November 2018. These questions were: What do you know about mandatory vaccination? What do you think of mandatory vaccination? Do you feel comfortable with mandatory vaccination?

An analysis method of open coding shows that the exploration of the scientific concept is restricted by the way of problematizing this SAQ. The explanation level of scientific aspect of herd immunity concept is low, and surprisingly not higher in the responses of those who say they feel comfortable with the SAQ because of their scientific background. It highlights the importance of tackling on SAQs through precise, authentic and concrete situations instead of general considerations.

In what ways does the pandemic influenced teaching and interest for contagious - Swedish middle school pupils' reflections in the backdrop of Covid-19?

Anna-Clara Rönner, Anna Jakobsson and Niklas Gericke

For much of the past year the coronavirus 2019 (Covid-19) pandemic has had an enormous impact on the lives of individuals and communities around the world. The aims of this study are to investigate (I) 10 to 12-year-old Swedish pupils' views on how the ongoing Covid-19 pandemic influences their interests and understanding regarding contagion literacy (CL), and (II) from what source (biology education or informal settings) they perceive that their knowledge originates from. The study is based on the framework of CL that was defined as the health literacy required in daily life and that recommends what should be taught at compulsory schools. The framework specifies six content themes, of which four are used in this study to outline middle school pupils' comprehension. Data is collected by individual, semi-structured interviews with pupils' at schools located in various socio-economic areas. The interviews are transcribed and analysed thematically. Preliminary results show that pupils' perceive the ongoing pandemic to prompt many student-initiated questions and is creating more interactive and interesting learning situations. Most pupils say they have no experience CL from their formal biology teaching and that their knowledge derives mostly from sources outside school, such as news programs for children. To conclude, the interviewed Swedish middle school pupils' understanding of CL seems mainly to originate from informal domains, rather than from formal biology education. Hence, the results indicate that the Covid-19 pandemic spark interest among the pupils for the topic and that there is a potential for exploiting this interest in developing biology education at this school level.

Science teachers' views on how to approach scientific misinformation in schools.

Marcus Grace and Keith Smith

It is claimed that we live in a 'post-truth era' where objective scientific facts have been replaced by pseudoscience and fake news, and where feelings have more weight than evidence. Languishing in our information bubbles, misinformation can be left to go unchallenged; some can be dismissed as harmless or even ridiculous, but some can be life-threatening. Two socio-scientific issues have dominated the news recently – the COVID pandemic and climate change – both of which have brought the significance of fake news and pseudoscience into sharp focus around the world. It is therefore an opportune time to explore how teachers approach misinformation about these universally familiar issues with students in school science. This study reports on focus group discussions among science teachers (n=16) newly qualified from two universities in the UK. The teachers demonstrated a well-aligned view of the meaning and potential impact of scientific misinformation and fake news. They raised a wide variety of approaches to tackling misinformation in the classroom and discussed the associated constraints put on their teaching. They strongly supported promoting socio-scientific decision-making competence among students; but many were reluctant to include the impact of politics and the media in science teaching - with a generally unsympathetic dismissal of journalists and the media.

Time	Thursday, September 1st
09:00-10:30	Paper Session 5C - Scientific Thinking, Nature of Science and Argumentation
Location:	Building: XΩΔ01, Room: 109
Chair:	Andreani Baytelman

Dialogue between evolution and belief in the Israeli diverse education system: Biology education experts' views

Netta Dagan, Tali Tal and Masha Tsaushu

Despite the religious and ethnic diversity, the same science curricula are taught to all Israeli students. Studies have shown theological and pedagogical difficulties related to teaching evolution, especially those associated with religious, cultural and social factors. These difficulties are common to all ethnic and religious groups in Israel, and might disrupt learning or raise conflicts between teachers and students. Additionally, students can demonstrate understanding yet not accept evolution, thus undermining a main goal of science education related to understanding the nature of science. The key objective of this study is to identify the views of biology-education experts and policy makers, from various ethnic and religious groups in Israel, regarding a possible dialogue between evolution and beliefs in biology classes in secondary schools.

Data collection from 32 experts in biology education included semi-structured interviews and a Delphi-study. The data analysis of the two instruments shows that most participants, regardless of religion or religious practice, believe that teachers should encourage the discussion of the conflicts. Despite conceptual disagreement on whether to include the discussion of evolution and faith in the curriculum, most experts agreed that the topic should be addressed in class regardless if initiated by the teacher or the students. Such dialogue can help in addressing the emotional difficulties that undermine learning. Our findings suggest that pre- and in-service teacher education should provide appropriate tools and materials to address this dialogue.

Natural History Museum Visitors' Evolution Acceptance

Alexandra Moormann, Anna Beniermann and Daniela Fiedler

Natural History Museums (NHM) are authentic places for evolution and thus play an important role for informal and non-formal evolution learning. However, only few studies investigated NHM visitors' magnitudes of evolution acceptance. Results show that religious denomination, church attendance, knowledge about evolution, and education levels seem to be relevant predictors for NHM visitors' evolution acceptance. In our study we aim to investigate German NHM visitors' magnitudes of evolution acceptance by using four established science education instruments. We also examined if known predictors like knowledge about evolution and religious belief were relevant for our participants, too. Altogether, 209 NHM visitors participated in an online survey comprising instruments measuring evolution acceptance and knowledge as well as self-reported personal variables (e.g., age, gender, educational qualification, religious belief). We found that NHM visitors tend to have relatively high magnitudes of evolution acceptance but low levels of evolutionary knowledge. Regression analyses exposed that knowledge was a significant predictor for NHM visitors' evolution acceptance scores, while religious belief, education background, age, and gender were only relevant for some scales. Based on our results, we recommend researchers to consider thoughtfully their choice of an instrument, especially if they want to compare results with other findings.

Students' (12-13 years old) ideas about chance and evolution during the game Darwinium during a playful activity

Magali Coupaud, Jérémy Castéra, Miguel Rotenberg, Eric Tortochot, Corinne Jégou, Hélène Cheneval-Armand, Sabrina Marchi, Pascale Brandt-Pomares, Claire Coiffard-Marre and Alice Delserieys Pedregosa

This communication proposes a study based on a serious game currently being developed in order to address the concepts of chance and evolution, "Darwinium", intended for middle school. This project is a continuation of work that has highlighted the difficulties of understanding the concepts of evolution of life and the concepts of chance. This game puts middle school students in the position of researchers observing the evolution of chimeric animal populations placed in an experimental dome and having to report on this evolution in verbal narrative form (written and oral explanation of evolution) and graphically (representation of the population). This narrative is an element of play and a means of observing the learning generated by the play activity. This paper proposes a case study based on a game situation with 12-13 year old students. A semio-cognitive analysis of the written and graphic productions of the players and the transcription of the verbatim of the game allows us to discuss the use of a play activity to address the concepts of chance and evolution with middle school students.

Investigating relationships between epistemological beliefs and personal beliefs in biological evolution

Andreani Baytelman, Theonitsa Loizou and Salomi Hadjiconstantinou

The present study investigates whether students' epistemological beliefs can predict their personal beliefs in biological evolution. Fifty one (51) 12th grade students participated in the study. Participants' epistemological beliefs and personal beliefs in biological evolution were assessed separately. Results showed that 12th grade students' epistemological beliefs predicted their personal beliefs in animal-evolution and plant-evolution, but not in human-evolution. In particular, students with relatively sophisticated epistemological beliefs, particularly beliefs about the source of knowledge, believe more in animal-evolution and plant-evolution, than students with less sophisticated epistemological beliefs. Educational implications are discussed.

10:30-11:00	Coffee Break
Location:	1 st floor balcony

Time	Thursday, September 1st
11:00-12:30	Parallel Paper Session 6
	Paper Session 6A - Students' Values, Attitudes and Decision Making
Location:	Building: XΩΔ01, Room: 103
Chair:	Marcus Hammann

Secondary school students facing fashion consumption and disposal

Isabel Banos-González, Patricia Esteve Guirao, Mercedes Jaén and Maria Ángeles García Fortes

In this work we address the problems of the growing production of textile disposals with 10th grade students (n=48). Specifically, we try to identify the students' portrait as clothing consumers, to assess their perceived responsibility about the problem and to recognise their willingness to carry out certain actions regarding clothing consumption. To gather the data, we used an activity based on a news about "the dark side of fashion", combining open and multiple-choice questions with 8 Likert-type questions. Results show that patterns of sustainable clothing consumption are not frequent and ignorance about the impacts of 'fast fashion' is widespread among our students. They assume certain personal responsibility in the face of these problems; however, when assessing possible changes in their habits, there is reluctance to assume deeper changes in their decisions. Regarding gender, statistically significant differences were found. Although girls seem to be more susceptible to trends, they are the ones who assume greater personal responsibility and willingness to carry out certain actions towards more sustainable habits.

Factors influencing the intention of students in regard to stem cell donation for leukaemia patients - a comparison of non-intenders and intenders

Julia Holzer and Doris Elster

This study investigates factors influencing students' intention to donate stem cells to leukaemia patients. As a theoretical framework an extended model based on the Theory of Planned Behaviour (TPB) is used, the TPB+ model. TPB+ model includes motivational internal factors of TPB (behavioural, normative and control beliefs), and selected external factors such as knowledge, moral obligation, moral reasoning, self-identity as a helper, and empathy, which were identified as influencing factors especially in studies about blood donation. Based on the theoretical frame the teaching unit "Wake up - sensitisation for stem cell donation" was developed and conducted with 94 10 to 12-graders from German high schools. The research question was: To what extent do the measured constructs of TPB+ change among non-intenders and intenders (students with high or low levels in intention for a stem-cell donation), after participation in the "Wake up" teaching unit? The participants completed a questionnaire before and after the teaching unit "Wake up". The data were analysed with t-tests. The findings demonstrate that the teaching unit influences significantly some factors (e.g. negative attitude-related beliefs, control beliefs, moral obligation and subject knowledge) as well as the intention of non-intenders as well of intenders for stem cell donation.

Learning about intraspecific biodiversity conservation with "Jack and the Beanstalk"

Joana Rios Da Rocha, Patrícia Pessoa, Lisa Afonso, Xana Sá-Pinto and J. Bernardino Lopes

Although the dialogue between literary education and science education is beneficial to the students' learning process, this kind of dynamics is still not very frequent and the results in terms of students learning that result from them tend not to be evaluated. Science education should foster student's engagement in scientific practices and discussions, while providing them with opportunities to learn about science in the context of social problems and move beyond the customary curricular constraints. In the present work, we describe a pilot study of a proposal for an educational activity, composed of 3 sessions, that articulates literary and science education that allows students to explore the importance of intraspecific diversity for the adaptation of species to different environmental conditions and to engage in scientific practices planning and implement experimental activities. The study was applied in a class of

4th grade with 25 students. To evaluate the potential of this educational activity to promote changes in students' behaviour and attitudes towards the intraspecific biodiversity of agricultural species, all students performed a test to assess and analyse their choices towards domestic plant biodiversity, before and after being exposed to the educational activity. Our preliminary results show a strong increase in the frequency of students choosing the most diverse option, although the sample size should be increased to approximately 100 participants to find significant differences in the outcome, using the McNemar test. These results highlight the potential of this educational programme to foster students' positive behaviours and attitudes towards intraspecific biodiversity.

Teach consensus, not controversy: Using science communication strategies to affect students' acceptance of evolutionary theory

Isa Marie Korfmacher, Christiane Konnemann and Marcus Hammann

From a scientific perspective, evolutionary theory is undisputedly the unifying theory of modern biosciences and is accordingly supported by almost all bioscientists. However, not only creationists continue to question this scientific consensus. Studies from science communication show that perceptions of scientific consensus play a central role in the formation of one's beliefs about and acceptance of an issue, and that these perceptions can be intentionally affected using appropriate science communication strategies. In this study, selected science communication strategies (scientific consensus, and social consensus messaging) were applied to evolutionary theory to identify the extent to which these strategies influence perceptions and acceptance of the topic. For this purpose, a text from a standard textbook on evolution was modified in a factorial 2x2 design (factor 1: scientific consensus, factor 2: social consensus). German secondary school students (n=185, 15-18 years old, 113 female) were randomly assigned to one of the four text variants and answered a closed ended questionnaire in a pre-post design before and after reading the text. The students' results show that both perceived scientific consensus and perceived social consensus were significant factors related to students' acceptance of evolutionary theory, and that social consensus estimates were affected by experimental manipulation of social consensus information. We conclude that communicating consensus about evolution with different communication strategies has an impact both on perceived scientific and social consensus. Educational implications for communicating scientific and social consensus when teaching evolution are discussed.

Time	Thursday, September 1st
11:00-12:30	Paper Session 6B - Teaching and Learning with Educational Technology
Location:	Building: XΩΔ01, Room: 109
Chair:	Gregor Torkar

Understanding the complexity of the human circulatory system using educational materials with or without augmented reality support

Gregor Torkar, Tanja GregorČič and Andreja Dolenc

Understanding the human body as a system is challenging for students due to its complexity. This study examines how Slovenian lower secondary school students understand the circulatory system, using the structure–behaviour–function (SBF) framework for conceptual representation. It evaluates the progress of students' perception after interventions with two different teaching approaches: one using a biology textbook supported by augmented reality (AR) technology, and the other using only a textbook as a source of information. The data analysis is based on the assumption that systemic understanding demands the perception of three system dimensions: the components forming the system at all levels of organization (its structures), the interactions and mechanisms between them (its behaviour), and the function as a whole outcome (its phenomena). The results indicate that both approaches contribute to a higher level of understanding the complex circulatory system. The group with the AR support showed statistically significant better improvements in their knowledge of the circulatory system, including all components of the SBF framework.

A comprehensive framework for understanding biology teachers' use of digital technology

Daniela Mahler and Julia Arnold

Digital technology provides different potentials for learning biology (e.g., by supporting the understanding of abstract issues). To ensure that potentials are actually used, the biology teacher and his or her willingness play an important role. Different models, such as the technology acceptance model, help to understand biology teachers' use of digital technology by taking into account different motivational factors (perceived usefulness, perceived ease of use, resistance to change, anxiety, social norm, facilitating conditions) and attitudes towards use as well as their impact on the intention to use digital technology. However, existing frameworks have gaps that the presented study attempts to address. We propose to include biology teachers' academic self-concept on technology-related professional knowledge (TPACK). The study aims to empirically test this extension using data from 403 prospective biology teachers with path models. Results show direct relationships between academic self-concept and motivational factors. The relationship between academic self-concept and the intention to use is mediated by motivational factors. Furthermore, we found that the motivational factors are directly related to the attitudes and the intention to use. The inclusion of academic self-concept in the path model leads to an increase in variance explanation in intention to use. The results support assumptions from existing models and show that the addition of academic self-concept contributes to a better understanding of biology teachers' technology use.

Biotechnology at school - digital or analog learning environment?

Julia Stich and Claudia Nerdel

Due to the Covid-19 pandemic, the use of digital media in the school context has increased significantly. Educational videos, educational software or digital laboratories are intended to help students better achieve their learning goals. The aim of the study is to make a further contribution to clarifying the extent to which face-to-face or digital teaching, or their combination, can be effective for learning with regard to practice-oriented subject areas such as scientific work. The study was conducted in the summer of 2021 with students of (specialized) upper secondary schools (N=172) aged 17-18 in one school morning. In order to investigate the effectiveness of the ecologically valid variants, the analogue (A) and digital

(D) learning environments were systematically varied according to the school situation. This results in the scenarios AA, AD, DA and DD. This is implemented by using an interactive book in comparison to classical teaching and a virtual laboratory for biotechnology in comparison to the corresponding analogue student experiment. In a pre-post design by quantitative questionnaire, it was determined how knowledge and knowledge gain in the context of PCR and gel electrophoresis develop under the presentation of the different learning environments. The first results show that the students found the content presentation forms positive in all scenarios. Further results will follow. These are highly relevant for the use of digital learning environments as a possible standard medium for teaching biology, as here we worked with students under real conditions.

Authentic Biological Dataset-driven Instruction Promotes High-Order Inquiry Thinking

Carmel Bar and Anat Yarden

A central part of inquiry thinking is the ability to ask fruitful research questions. Previous works showed that the order of students' questions improves following inquiry-type experiments or reading research papers. Here we analyzed 707 questions asked by 209 students and teachers before and after dataset-driven instruction unit focusing on gazelles. The instruction unit includes an authentic large-scale dataset containing thousands of measurements of gazelles, collected over 75 years. The instruction unit is shown to enable students and teachers alike to ask higher-order research questions. Before using the unit, most questions focused on gazelle properties (first-order questions). After using the activity, most questions were in the second and third-order. Furthermore, questions involving at least one discrete variable (such as gazelle sex, country of origin, or developmental stage) tend to be second-order comparative questions. In contrast, when the research questions contain two continuous variables (such as weight or length), questions tend to be third-order contingencies questions. Thus, engaging with large datasets, enables high order question asking, alongside identifying correlations, using visualizations, and practicing data literacy in an authentic context. Our findings indicate that dataset-driven instruction is fruitful in promoting high-order inquiry thinking, thus expanding the biology teacher's toolbox in teaching inquiry and data literacy.

Time	Thursday, September 1st
11:00-12:30	Paper Session 6C - Outdoor and Environmental Education Symposium 3 - The Call for Action in Environmental and Sustainability Education
Location:	Building: XΩΔ01, Room: 108
Chair:	Jelle Boeve-de Pauw

“Don’t we all have a responsibility to act?” – Action competence as driver for young people’s climate action

Carola Garrecht, Niklas Gericke, Nina Christenson and Ute Harm

Enabling students to engage with socioscientific issues has been described as a central aim of modern science education. This includes equipping students with the knowledge and skills necessary to take responsible action in the light of pressing issues such as climate change. Consistent with this aim, action competence defines the (1) knowledge, (2) willingness, and (3) efficacy that theoretically characterise those students who are able to take conscious action on climate-related issues. To date, however, there has been a lack of research on the extent to which action competence influences young people’s climate action, and there is only scattered evidence on the role that biology education can play in this regard. To address this gap, the present study examines which aspects of action competence young people consider most relevant when reporting on their climate action. Twenty-eight semi-structured interviews were conducted in Sweden and Germany (N = 14 interviews per country) with young adults who are actively engaged in climate movements such as Fridays-for-Future. The interview data is analysed using the method of qualitative content analysis. Preliminary results suggest that the aspect of efficacy is particularly strong among participants while knowledge about climate change is rather seen as a threshold for action. For biology education, these results argue for a stronger link between climate-related content knowledge and its application to evaluate the effectiveness of climate-related actions.

Biology and science teachers view on critical thinking in sustainability education – The need for a multidisciplinary approach for action competence

Ragnhild Lyngved Staberg, Annette Lykknes, Teresa Berglund, Eli Munkebye, Eldri Scheie, Maren Skjelstad Fredagsvik, Tove Grete Lie, Marthe Lønnum, Sonia Martins Felix, Stephan Daus and Niklas Gericke

Critical thinking (CT) has been proposed to be a basic competence in sustainability education to develop students into action competent individuals in complex environmental issues. In sustainability education an interdisciplinary approach is suggested to deal with these complex problems, but in research it is discussed whether CT skills are domain-specific or can be generalized across different school subjects. Therefore, it is of importance to investigate how primary biology and science teachers understand CT in relation to teachers of other subjects. In this study we investigate how Norwegian biology and science teachers in primary school understand CT. The study design is of a mixed method approach including a teacher questionnaire from schools all over Norway, and focus group interviews with a sample of teachers. In total, 921 Norwegian primary school teachers answered the questionnaire, of which 135 were science teachers. Of those who completed the survey, teachers from three different schools teaching 5th to 7th grade (N=34), were selected to take part in focus group semi-structured interviews. Descriptive statistics and thematic analysis was conducted. The main findings from the study indicate that the primary biology and science teachers, when compared to other teachers (social science and mother tongue teachers predominantly) view CT as an approach where the teachers should be objective, ignoring values and emotions. The focus of CT among biology and science teachers is on nature of science rather than argumentation, shift in perspectives and source criticism. They focus on the importance to teach about evidence based knowledge with the ability to make predictions, and the difference between science and other belief systems. To conclude, primary biology and science teachers will find it difficult to enact CT within sustainability education themselves if all aspects of CT is to be addressed. These preliminary findings call for a multidisciplinary approach in which biology

and science teachers ought to collaborate with teachers in other school subjects when teaching CT in sustainability education with the aim to develop students action competence for sustainability.

Effective Education for Sustainable Development

Wanda Sass, Eleni Sinakou, Els De Smet, Brigitte Pycke, Miette Plessers, Bea Merckx, Thomas Remerie, Eef Thoen, Sven De Maeyer, Vincent Donche, Peter Van Petegem and Jelle Boeve-de Pauw

In this contribution we present key results from several studies that were all part of the VALIES project. In this large scale longitudinal research and development project, we designed a teacher professional development program and implemented it in over 50 school across Flanders (Belgium). We collected data from 2000+ students and 750+ teachers at different timepoints across the schools' participation in the professional development program. The data allows us to study students' action competence in sustainable development and (student' perceptions of their) teachers' beliefs and practices in ESD. Longitudinal analyses reveal that students' action competence differ significantly and meaningfully between schools, and evolves as school progress through the VALIES project. The results also highlight the mediating role that action orientation with ESD has on students' action competence. In this presentation we will show how the professional development program for the school teams supported them to understand and value action competence as a major learning outcomes of education for sustainable development, as well as how we provided levers for the school teams to bring ESD, and specifically action-orientation, into practice in their education.

12:30-13:45	Lunch
Location:	Restaurant A.Zorbas

Time	Thursday, September 1st
13:45-15:30	Parallel Poster Session 2
	Poster Session 2A - Teaching Strategies and Learning Environments
Location:	Building: XΩΔ01, Room: 102
Chair:	Franziska Schisslbauer

"It is just really a different way to teach science" - Teachers' experience with citizen science

Julia Lorke and Maria Aristeidou

Citizen science provides teachers and their students with opportunities to contribute to authentic research. An increasing number of studies finds evidence that learning outcomes - ranging from gains in content knowledge to the development of stewardship and scientific citizenship - can be achieved through participation in citizen science projects. For the implementation of citizen science in formal education, teachers act as gatekeepers because they decide whether to engage students in citizen science or not. In our first study presented in this paper, we seek to gather the expertise of teachers who have already participated in citizen science with their students. We invited teachers to participate in a survey study (N = 56) and an interview study (N = 11), independent of their country of residence, their school type, and their teaching subject. The results add to our understanding of teachers' motivation, types of activities they engaged in, the challenges they faced, and their recommendations for others aiming to implement citizen science in their classrooms. Building on the results of the first study, a cohort of biology teachers in Germany have been recruited for an introductory workshop into citizen science and the implementation of three citizen science projects into their teaching over the course of two school years. They will be interviewed pre-participation and after each project implementation. This will allow us to see whether the implementation of citizen science has any impact on the teachers' motivation, teaching strategies or their professional identity.

The effect of adult intervention in the development of science process skills

María Napal Fraile, Lara Vázquez Bienzobas, Irantzu Uriz Doray and Isabel Zudaire

Contrary to the commonly held belief that preschool children are not prepared for understanding certain scientific phenomena, studies have shown at least incipient command of scientific skills (SPS), whenever children are provided with various opportunities and contexts for learning. Specifically, the degree of adult intervention may strongly determine learning outcomes, especially if this role consists of guiding exploration with productive questions that help the children focus their attention on the phenomena of interest. This research was aimed at assessing the impact of different styles of adult intervention on the learning and on the engagement with science tasks, in the context of a proposal intended to develop SPS among young children. 42 children aged 4 to 6 participated in either a proposal involving magnetism (n=27) or the observation of ants (n=15). They were subdivided in three groups and subjected to different interventions: children-led, adult-led or guided exploration. The three styles resulted on conceptual learning gains and development of SPS, with some nuances: while the adult-led group attained the most detailed learning of concepts, the guided exploration group improved more their basic SPS. Children-led intervention had the poorest results. The choice of the topic and contexts for the research, and the instruments and materials provided were key for the development of SPS. Moreover, the type of questions proved crucial, with productive questions that prompt the children to focus their attention or find a solution leading to much more accurate and complete answers.

The impact of lockdown on students' knowledge of evolution

Jelka Strgar

In the spring of 2020, the educational process was severely impacted by the lockdown due to the Sars-Cov-2 pandemic. During these spring months, biology teachers in Slovenia usually deal with the topic of evolution for students aged 13-14 years. Therefore, the main objective

of this study was to investigate the impact of the lockdown on Slovenian students' knowledge of evolution and possible weaknesses in their knowledge. Our sample consisted of 389 participants, including 168 students aged 12-13 who were not yet familiar with the topic of evolution and 221 students aged 14-15 who were expected to have covered the topic of evolution during the lockdown. Data were collected via the 1KA web instrument using an anonymous knowledge test with a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). Results show that 14-15 year olds' knowledge of human evolution and evolutionary theory was just above average, which we consider satisfactory. Despite the lockdown, students significantly improved their knowledge of human evolution. In contrast, knowledge of evolutionary theory did not improve at all. Further research is needed to explain why knowledge of evolutionary theory did not improve and why students showed satisfactory knowledge of evolutionary theory even before they were expected to learn this topic in class.

Explaining diversity – Educating about race: A study with biology student teachers

Franziska Schisslbauer and Arne Dittmer

The FALKE project is located in the professional research of prospective teachers and, in addition to general quality criteria for good explanations, primarily investigates the adaptivity of explanations in pedagogical interactions with pupils as well as the role of reflection in teacher education. In the interdisciplinary project, the perspective of biology education deals with explaining genetic diversity on the base of population genetic mechanisms and refers to the ethical-political debate about diversity and racism as well as dealing with uncertainty. Because the genetic diversity of humans cannot be described by the division into certain 'races', the concept of race will be critically addressed in the seminar- the goal is a diversity-sensitive biology education. But not only diversity and racism are complex topics – education itself is determined to be complex and necessarily confronts its actors with planning or control problems. Teachers are confronted with uncertainty in their profession and therefore need to build strategies for dealing with it. In order to address the contingency of teaching and its effects, adaptivity is not only desirable, but essential. Accepting uncertainty in the process of teaching as a challenge and not a problem, and engaging in the uncertainties that arise in the situation, represents a driving force of competence development. And that's what the FALKE-project in Biology is looking at: the adaptations in explanations of sensitive ethical issues as well as the correlation with the tolerances for uncertainty and ambiguity.

A Systematic Review on the Use of Narrative Methods in Biology Education

Julia Zdunek and Jörg Zabel

A large amount of well-established theoretical evidence on the valuable use of narrative methods in science education contrasts with a smaller number of empirical works in this field. However, the empirical findings cover many different contexts, goals and target groups, making the research field appear like an unstructured landscape. The lack of systematisation makes it difficult to uncover the possibilities of an enriching use of narrative methods in biology education. To structure the research field, we build on Avraamidou and Osborn's work and conduct a Systematic Review of the empirical literature on narratives in biology education since 2009. The aim is to investigate how narrative methods are used to promote understanding in the teaching of biology. Thereby, our research is inspired by a conception of understanding that emphasises the personal meaningfulness of biological learning contexts for students and aims for a holistic education. To analyse the literature, we create an inductive category system following Kuckartz's qualitative content analysis. First results show 6 preliminary categories. One category indicates two different notions of understanding in the empirical research on narratives in biology education. The narrow notion focuses on the cognitive components of understanding. The broad category is extended by subjectivising components.

Development of preservice biology teachers' PCK: Quantitative and qualitative analyses

Denise Bock, Daniela Mahler and Ute Harms

This longitudinal study addresses the development of preservice biology teachers' pedagogical content knowledge (PCK) focusing on knowledge about instructional strategies

and knowledge about students' understanding. PCK is the unique knowledge of teachers necessary to teach biology and make it comprehensible to students. To acquire PCK, university teacher education is a significant phase. To evaluate and improve biology teacher education, examining preservice teachers' PCK development is critical. So far, longitudinal studies mainly cover topic- and situation-specific PCK as well as particular teaching programs. Cross-sectional studies, however, investigate broader PCK but they are not sufficient to get insight into PCK development. In our study, we therefore analyzed longitudinal data based on a comprehensive PCK instrument to examine (1) with how much PCK preservice biology teachers start with at the beginning of teacher education, (2) how much and what they learn over the course of study and (3) how stable the acquired PCK is during their university studies. PCK of 299 preservice biology teachers was assessed at 4 time points between 2014 and 2017. The instrument consisted of 34 items related to knowledge about instructional strategies and students' understanding in the subject of biology. Entry scores (RQ 1), difference scores (RQ 2), as well as the consistency of correctly answered items (RQ 3) were considered. Data were analyzed quantitatively and qualitatively (analyses of scale-level scores, item analyses regarding specific educational aspects and biological topics).

The role of study buddies in promoting interest in biodiversity and species literacy

Mario Stehle, Jonathan Hense and Annette Scheersoi

Society's species knowledge is very low, yet a broad and deep knowledge of species, also known as species literacy, is crucial for protecting our environment. Accordingly, focusing out-of-school educational programmes on improving species literacy could be a promising way to adequately address the current biodiversity crisis. Developing and maintaining interest plays a primary role here, as interest supports the acquisition of knowledge. According to Vygotsky's considerations on cognitive development (e.g., More Knowledgeable Other, MKO) and Deci & Ryan's emphasis on the fulfillment of the basic psychological needs (i.e., social relatedness), this study aims at identifying if and how accompanying teacher students (study buddies) can have a positive impact on adolescents' interest development in biodiversity and support species literacy acquisition. Initially, a comprehensive literature review concerning the topics of species knowledge and teaching-learning arrangements as well as different empirical studies during out-of-school educational programmes were conducted. The results allow for a clear distinction between study buddies and other MKOs, such as mentors or peers. The findings also indicate how adolescents' interest in biodiversity and species literacy can be developed through social interactions between learners and study buddies and how their specific characteristics impact this developmental process. Further empirical studies using the design-based research approach will be conducted to differentiate and extend these findings and to derive design-recommendations for educational practice.

Implementation of biotechnology topics into School Curriculum: findings of a case study on teacher training courses

Sara Großbruchhaus, Patricia Schöppner and Claudia Nerdel

Recently, the model of teacher training effectiveness was extended to a fifth layer where teacher training can influence school development when addressing the faculty (Rzejak & Lipowsky, 2019). This study examines the extent to which a teacher training on biotechnology (Nerdel & Schöppner, 2021) can make a contribution to school development. We interviewed 39 trained teachers, 20 of whom implemented the content of the teacher training at their own biology courses. We coded the interview data using a research based category system and gained a Cohen's Kappa of 0,88 based on an 80% overlap of the codes by double coding approx. 30% of the transcripts (Brennan & Prediger, 1981). Here, we present a case study of an upper vocational school that has integrated the training content over several years. Both teachers state a high level of cooperation within the faculty and describe their procedure as loop: (1) organizing roundtable, (2) implementation, (3) students evaluation, (4) feedback roundtable, (5) adjustments. This lead to a complex implementation system over two grades that gathered a reputation among students. The results show that the different modules of the teacher training (Nerdel & Schöppner, 2021) are highly adaptive to the individual needs of the schools. Therefore, we conclude that the teacher training fulfils sufficient conditions regarding

design and practicability. Within analysing the other interviews, we expect to gather further insight within which circumstances conditions for implementation are sufficient or necessary.

Suggestion for biology classes using the poem *The Baptism at the Savica*

Andrej Šorgo, Tilen Kos, Nina Rupar, Sara Senčar, Sanja Zadavec and Tadej Zorko

To address some of the most common criticisms, namely that teaching is overloaded with facts, that the most important thing is grading and not knowledge, and that the content and school work within a subject is not connected to the other subjects and overall to the "real" world of the students, a project combining biology and poetry was tested with a group of prospective biology teachers. Their task was to analyse the poem *The Baptism at the Savica* (Prešeren, F. 1800 - 1848) and extract all the key words that have biological or ecosystem connotations, then find thematically organised generic terms (e.g. pulmonary system), provide a biological explanation of the term, find the objectives in the lower secondary school biology curriculum in which the reference to the poem can be made, and propose a practical activity in which the term can be used. The final assignment was to write a term paper that was presented and defended at the end of the course. The students were able to find 159 words related to biology and ecology in the text. The words extracted from the poem were assigned to the following biological areas: a) human anatomy and physiology (human body; circulatory system; sensory system; respiration; digestive system and nutrition; disease and emotions) b) life and evolution; c) ecosystem; d) energy sources; e) times of day; f) human impact on nature and the environment; g) plants and animals; h) genetics and heredity. They identify about 120 learning objectives and suggest about 45 hands-on activities and laboratory exercises.

Time	Thursday, September 1st
13:45-15:30	Poster Session 2B - Scientific Thinking, Nature of Science and Argumentation
Location:	Building: XΩΔ01, Room: 104
Chair:	Katrin Vaino

Change of Understanding of Nature of Science of Pupils of Secondary Classes of Scientific Inquiry in School Garden as a Learning Place

Torsten Kreher

An aim of school education is to impart general knowledge to pupils. Scientific literacy is a part of general knowledge. It is recognized that it is important to understand the nature of science to become scientific-literate. Amongst others, an understanding of nature of science is gained by scientific inquiry. This study investigates if scientific inquiry at school garden changes the understanding of nature of science of pupils in secondary class. Therefore, the curricular biology lessons include teaching and tasks at school garden. One half of the pupils of each participating classes were taught in school garden and solved tasks regularly and independently there. The other half got the same teaching and solved the same tasks but in classroom. The focus of the lessons were on scientific literacy. The biology lessons during the intervention were in the second half of the school year 2018/2019 with pupils of a 9th grade. The sample consisted of a total of 110 pupils (51 girls and 59 boys). The average age of the pupils' was about 15 years. The influence of classroom and school garden as learning places on changing pupils ideas about nature of science is examined. The results of the pre-post test show that career aspirations of pupils have stronger influence on changing ideas about nature of sciences than the learning place.

“Post-truth” challenges and associated science education responses

Katrin Vaino, Anastasiya Astapova, Hans Orru, Konstantinos Korfiatis, Ana Valdmann and Oleg Popov

The goal of this study is to identify the challenges of “post-truth” that science education needs to address and to suggest how these can be met. Based on the literature, four types of challenges are identified: (1) people’s lack of knowledge and skills to assess the reliability of information and recognize misinformation, or common tactics used by conspiracy theorists, (2) lack of commitment to objective facts, (3) lack of a shared understanding of ways of helping people to decide which ways of knowing are more reliable than others, and (4) a lack of understanding that all science knowledge is socially constructed. As a response, respective knowledge and skills need to be taught to students in order to “vaccinate” them against wrong, or biased information before they begin to believe in it. More attention must be paid to the development of well-established science identities and virtues by students. Epistemic disagreements on which ways of knowing are reliable must be seen as educational opportunities for learning to undertake critical analysis. And finally, updated meaning and more importance need to be given to educational approaches demonstrating the interplay between science, technology and society in science classrooms. Based on these four highlights, six teaching-learning modules on controversial issues such as viruses, climate change, evolution, etc. are developed and tested in the Erasmus+ project EVIDENCE for students (age group 15-18).

Students’ explanations in model-based abductive reasoning about co-evolutionary phenomena

Johanna Penzlin, Dirk Krüger and Annette Upmeier zu Belzen

Explanation is an essential part of scientific research to generate knowledge, while in learning contexts explaining is mostly about the generation of understanding. Biological explanations are characterised by typical structures, types, and references to different levels of biological organisation. According to scientific reasoning, knowledge-expanding explanations are products of abductive reasoning and play an important role during model construction as part of the modeling process. In this study, biology students were asked to generate explanations for phenomena in the context of co-evolution. Each student (N=68) was randomly assigned

to one out of three phenomena that differ in the addressed organisational level. As background variables, we assessed cognitive load during task processing and content knowledge about evolution. The written explanations will be analysed by qualitative content analysis according to shown types and structures of biological explanations, abductive reasoning processes, and levels of organisation. Results will be triangulated with the data for the background variables. The studies' results aim to contribute to the understanding of structures and types of abductive explanations in biology and to create a basis for promoting cross-level scientific thinking for biology education contexts.

Potential of partly structured group-based negotiation on socioscientific issues to initiate more meaningful and deeper interaction

Maria Jafari, Maren Koberstein-Schwarz, Christina Priert, Florian Böttcher, René Leubecher and Anke Meisert

The study investigates group-based negotiation processes on socioscientific issues (SSI) in biology classes structured with an instrument called target-mat. The study investigates the process of negotiation and the extent to which students engage in more in-depth discussions about the issues instead of simply solving the instructional tasks (especially reasoning and weighting). In the corresponding intervention study, 31 students from a German middle school discussed arguments for and against the construction of an amusement park in the nearby forest. These arguments were individually reasoned and weighted in the previous phase of the intervention. To examine the process of SSI-related group-based negotiation processes, different interaction types between group members were identified in terms of controversial nature. Preliminary results indicate that all students were involved in the group discussions. Regarding the controversial nature, in average two out of eight segments (i.e., delimited parts within the discussion) an initial consensus could be identified. Regarding their interactive character, these two segments exhibited fewer student contributions and less interaction activity. Exceeding previous findings on the potential of target-mats to activate and reconsider argumentative resources (Jafari & Meisert, 2019), the analysis confirms that structuring students' SSI-related discourse through the target-mat enables students to both systematically reflect on the justification of arguments and their weight as well as initiate coherent discursive activities related to situated controversies.

Giftedness in biology within the Cattell-Horn-Carroll theory – Basis for the development of a screening tool to identify gifted students in biology

Colin Peperkorn and Claas Wegner

Although gifted behaviour is expressed in different ways depending on the subject, there are no tools for screening science-subject-specific giftedness in children at an elementary school age. Existing data from intelligence research can help to understand the peculiarities of different kinds of giftedness. To find a valid basis for the development of a subject-specific giftedness screening tool in biology, we conducted a theoretical analysis of different conceptions of giftedness in biology. Therefore, we used the Cattell-Horn-Carroll theory of intelligence, as it provides a usable framework to classify indicator competencies and traits of giftedness. According to this theory, the construct of intelligence can be divided in three different strata. During our analysis, we classified all indicator competencies of giftedness in biology we found in existing research by allocating them within this hierarchical model to find a valid basis for a test development. To confirm our findings, different experts and teachers from giftedness research conducted the analysis and we calculated an inter-rater-reliability. Our results point out that giftedness screening tools respectively diagnosis tests should offer different types of tasks than classic intelligence tests. Existing tests mainly focus on a high discriminatory power between different broad abilities like fluid or crystallized intelligence (Gf / Gc). Subject-specific gifted behaviour only occurs through the combination and the intuitive switch between different abilities according to the given situation, which needs to be considered in giftedness diagnosis. Detailed results of our analysis and indications for a test development process will be presented at ERIDOB 2022.

Preservice Elementary Teacher's System thinking when Proposing Actions to Prevent Pandemics as COVID-19

Aritz Uskola and Blanca Puig

During the COVID-19 pandemic, citizens all over the world were called upon to take actions to stop the spread of the disease. However, little information regarding the environmental and animal factors that influence the emergence of epidemics was spread by media, compared to its transmission and effects on human health. This study aims to explore the systems thinking ability shown by 47 preservice elementary teachers when they proposed actions to avoid the emergence of future pandemics, individually and in groups after reading scientific texts. Content analysis of written responses was applied for addressing the research questions, focusing on the dimensions of the One Health approach and the level of system thinking reflected. Most participants focused first on the human dimension and a few mentioned environmental and animal dimensions, which is consistent with the guidelines given by governments to citizens to act against the current pandemic, and reflects the low media and studies coverage of these areas in relation to the emergence of pandemics. All actions proposed by groups, after they have accessed information, included the three dimensions of the One Health notion. They also showed a higher ability to identify and explain the interrelationships between the environmental and animal health and human health. This points to the need to design activities in which students could contrast and exchange their own views with others

Language aspects in teaching biomedical subjects

Alesia Sharun and Tetiana Krushynska

The confident knowledge of English is absolutely needed for international scientific communication at the present time. In this work, we have tried to highlight some aspects of teaching biomedical subjects in English. The importance of English in higher school and biomedical education is considered with an example of Language skills medical, dentistry, and pharmacy students are becoming an object of verification at the level of the Testing Board of the Ministry of Health of Ukraine. The point is that preparing students for the licensing exam, which includes an English component, is the task of not only linguistic faculties, but also biomedical ones. This research was carried out on the materials of microbiology classes for second and third-year students of DSMU by analysis of students' written tasks completed with the help of a language translation program, observing of students' activity during use of some English video learning materials, methods of formal conversation and testing. The analysis of normative documentation on the educational process organization was also made. Assessment of the role and volume of the English knowledge was made in the condition of new curricula for masters of Medicine, Stomatology, and Pharmacy in Ukraine.

Medical student's prospective reflection on studying microbiology

Tetiana Krushynska, Alesia Sharun, Iryna Zhernosekova, Iryna Stetsenko and Dmytro Stepanskyi

Reflection in Didactics provides a lot of opportunities for students' motivation and engagement, their self-assessment, and self-regulation. Biological sciences are the ground part of the curricula of junior medical students. Thus, research into their reflection of the Microbiology content is of sure practical interest. The research was focused on revealing aspects of Microbiology that are the most essential for the students (personally and professionally) and how it matches the current educational program. The methods of reflective interview, qualitative analysis, and Kember's critical reflection rubric were used. The study involved 136 students. Less than one-half of them demonstrated reflective skills, but their attitude to the reflective interview was responsible, that allowed preliminary data collection. The students' expectations of studying Microbiology in near future mostly were associated with advanced learning technologies and acquiring practical skills. The importance of Microbiology fundamentals, clinical thinking, and personal context were also mentioned. The most typical expectations for future profession were practical application and further knowledge development. However, students underestimate knowledge about infections prevention.

Comparison of students' expectations and regulatory educational documents revealed their persuasive correlation, except some General Competencies related to the cognitive sphere and self-regulation. Research has shown that in teaching Microbiology students' reflective skills, analytic capacities, and critical thinking should be improved. It might be done using problem-based learning, case studies, and interactive methods. Follow-up study will be about retrospective reflection, whether students' expectations are satisfied at the end of the Microbiology course.

Conceptualisation of genetic variation as a disciplinary core idea through different levels of schooling

Helen Semilarski, Regina Soobard and Miia Rannikmäe

This research identifies disciplinary core ideas, which are linked with a specific subject e.g. biology and elaborates on the examples of genetic variation. It is important to develop students wider interdisciplinary understanding about disciplinary core ideas such as genetic variation. Disciplinary core ideas focuses on processes and relationships. The example of genetic variation is important for students to understand about and interrelate evolution, biodiversity and ecosystems. Genetic variation can be taught over multiple school levels, progressing towards more in depth conceptualisations and greater complexity. Implementing an understanding of genetic variation prepare school students for higher levels of education and even professionally science-related careers such as, in this case, doctor, engineer, scientist or psychologist. The importance of genetic variation also helps in determining answers to large- scale issues, which may have a profound impact on society (e.g. genetic diseases). Structuring teaching and learning around disciplinary core ideas, instead of subject topics can help students to build a more expert-like integrated understanding, which can be used to solve complex problems. Through the disciplinary core ideas comprehensive understanding of the basic concepts, and skills is formed during different stages of study.

15:30-16:00	Coffee Break
Location:	1 st floor balcony

Time	Thursday, September 1st
16:00-17:30	Parallel Paper Session 7
	Paper Session 7A - Teaching Strategies and Learning Environments
Location:	Building: XΩΔ01, Room: 109
Chair:	Lina Varg

Intentions, plans and teaching practices in upper primary school

Lina Varg

While lesson plans may be of importance for student learning they take considerable time and effort for teachers to construct. Therefore, it is interesting that expert teachers have been found to spend less time on constructing elaborate plans and instead tend to rely on a set of teaching strategies to aid them in realizing their intentions in class. The present case study was conducted to contribute to research on the congruence between teachers' intentions, lesson plans and classroom teaching practices. Focus of the study was a grade 6 teacher who via constructed planning documents attempted to transform syllabus into enacted teaching. Data gathered from teacher interviews, curriculum, planning documents, and lesson observations enabled an analysis of the transformation process. Analysis of the data was done through inductive thematic analysis and the use of performance type categories to enable comparison between curriculum, planning documents, and teaching practices. Results show that the participating teacher constructed a comprehensive plan for the subject area, and closely tied it to syllabus text emphasizing the performance types 'Reasoning' and 'Communicating' skills. Further, it was found that the enacted teaching was inefficient in transferring the teacher's intentions for students to practice communication and reasoning into the classroom. The discrepancy is not believed to stem from the teacher's rejection of syllabus intentions, but rather a lack of suitable teaching strategies to allow for a more flexible teaching. An implication of the study is a highlighted need to offer in-service teachers professional development to strengthen teaching of communication skills.

Increasing student involvement with ecological dilemmas through a SSIBL-based photo/video project

Rik Kooke and Micha Ummels

Environmental literacy is an important attribute for students growing up in the 21st century. Many global issues, such as climate change, water and food shortages and bacterial and viral infections are fundamentally ecological issues that affect entire ecosystems. Students in secondary education are familiar with such issues, but they often lack awareness about the consequences and its complexity and they often do not realise how these issues are connected to their daily lives. Additionally, science teachers often find it difficult to address and discuss global issues inside the classroom, mostly because they lack expertise in teaching strategies to explore, share and discuss societal and personal aspects. Both matters, student misunderstanding and teacher discomfort, can potentially be addressed using a socio-scientific inquiry-based learning (SSIBL) approach. SSIBL consists of multiple phases among which students define a research question, do research, connect the research to societal aspects and try to come up with a solution. In this study, it is investigated how a SSIBL-based approach focusing on a photography/video exhibition and in which students are given freedom of choice and provide each other feedback, contributes to student involvement with ecological dilemmas. The project was conducted in two 10th-grade classes of in total 41 students, aged 15-16, in pre-university secondary education. Triangulation between pre- and post-surveys and semi-structured interviews showed that students' involvement with ecological dilemmas increased and indicated how several aspects of the project contributed to this.

Educational escape rooms: Exploring the use of engaging problem-solving learning activities in science education

Georgios Villias and Mark Winterbottom

The use of Educational Escape Rooms (EERs) in science education has been gaining ground among educators around the world. Even though both students and practitioners often recognize the EERs learning impact on students and speak in favor of their use in education, no concrete evidence exists to support these assertions. The current study attempts to fill this knowledge gap and provide research data that can be critically used to objectively evaluate EERs possible association with subject knowledge and 21st century skills' development.

Fostering learning on socio-scientific issues with escape games

Alice Veldkamp, Johanna Rebecca Niese, Martijn Heuvelmans, Marie-Christine P.J. Knippels and Wouter R. van Joolingen

This study investigates an escape game based on the concept of the popular escape rooms as a hybrid learning environment for the socio-scientific issue of zoonosis. The study focusses on the influence of the educational game design elements immersion, collaboration, and debriefing, on fostering learning. We based the design of the escape game on an educational game design framework that aligns the learning goal and the game goal, i.e. administering the vaccine in time. One-hundred-and-twenty-six students, aged between 16 and 20 played the escape game. Measures for learning were pre-and post-tests. The game experience was measured through questionnaires, classroom observations, and interviews with students and teachers. The results show a knowledge gain between pre-and post-test. Correlational analysis showed that all three design elements contributed to students' appreciation of the escape room, whereas only immersion had a direct contribution to knowledge gain. Based on the qualitative data it appeared that the used escape boxes contributed most to perceived immersion. Immersion helps students focus on each other and the tasks. Also, the distinct roles for each student within the narrative helped to evoke immersion. Teachers and students were satisfied with the combination of an escape game and debriefing afterwards, to address the conceptual knowledge and socio-scientific issues involved in the defeat of zoonosis. The study confirms the usability of the developed framework for educational game design.

Time	Thursday, September 1st
16:00-17:30	Paper Session 7B - Students' Conceptions and Conceptual Change
Location:	Building: XΩΔ01, Room: 103
Chair:	Isabel Zudaire

No error but not a good answer: assessing progressions towards the biology paradigm

Francois Lombard, Camille Larpin, Marie Sudries, Séverine Perron and Laura Weiss

Good answers are defined in classrooms by a discipline-specific paradigm. Understanding life in terms of its underlying molecular (M) mechanisms is the core of the current school biology paradigm and valid explanations are objective causalities (OC) - defining important characteristics of good responses. However, the explanations that students produce are often finalist, essentialist or anthropocentric. Education traditionally focuses on eliminating errors, which can lead to losing sight of progressions and formative guidance. Instruments to assess M-OC characteristics of student responses are needed to inform teacher guidance and to produce evidence for research on learning progressions. We present here an instrument (MOCS) to analyze student responses, producing a score for molecularity (M) and objective causality (OC). As an illustration of the heuristic power of MOCS we applied it to a body of student productions in a collaborative writing space. M and OC scores were coded during progressions. Consolidated score means were established by cohort and by item of the reference knowledge structure map (CMap). Progression profiles for each item were also established. While the differences between cohorts were moderate, different knowledge items produced great differences in mean scores and profiles. The heuristic power of MOCS in this example was confirmed as it empirically identified areas of the student understanding where score progressions were slow, or even decreased. Interestingly MOCS revealed very inconsistent progressions profiles across cohorts for some items. Uses of this evidence in guiding progressions and research will be discussed.

Bottom-up and top-down effects on the visual perception of data supporting the Balance of Nature or the Flux of Nature metaphor

Sabine Meister and Annette Upmeier zu Belzen

In this study, we investigated how visual perception of data in the context of population dynamics is related to characteristics of the data sets and initial conceptions. In doing so, we combined theoretical frameworks of cognition like top-down and bottom-up effects on visual perception and information processing with scientific reasoning processes leading to the model of data-based scientific reasoning (DbSR). To investigate top-down effects, we focused on initial conceptions regarding population dynamics that are distinguished based on their association to the balance of nature metaphor (BoN) or the flux of nature metaphor (FoN). Bottom-up effects are operationalized by presenting supporting and anomalous data regarding the initial conception as graphs in various ratios. Twenty pre-service biology teachers participated in the study and answered a partially digitalized instrument that was connected to an eye-tracking device to assess participants' visual perception of the shown data. We analysed initial conceptions by using qualitative content analysis and epistemic network analysis. Eye-tracking data were accumulated in pre-defined areas of interest and the metrics number of fixations and average fixation duration were analysed. Based on these analyses, our findings suggest that the characteristics of the different data sets that were either associated with the BoN or the FoN metaphor have a strong influence on perceptual processes during DbSR. FoN graphs seem to be more relevant indicated by the higher visual attention. However, initial conceptions regarding population dynamics had no significant effect on the visual perception of the different graph types.

Content analysis of grade 12 students' conceptual understanding of core concepts in biology

Helin Semilarski and Anne Laius

Biology education faces the major problem of how to educate young people in a constantly changing world. People need to be capable of making biologically justified decisions in their everyday life, especially regarding their health, e.g. vaccination, diet, type of treatment. This emphasises the need for every person to have at least basic knowledge of biological concepts and be able to apply competencies to solve different everyday problems. This has been stated by National Research Council. The standards in the next generation science standards (NGSS) reflect students biological needs (NGSS, 2013). Conceptual understanding is needed to develop higher level abilities that would enable them to apply their knowledge. The aim of this study is to determine grade 12 students' profiles of achievement in biology. 246 12th grade students participated in this study. The main results enabled a distinction between the students' latent profile models so as to detect the concepts that differentiated the students' conceptual understanding. These findings are discussed.

Who do I look like more, mom or dad? An exploratory survey about young children's ideas about variation of traits

Isabel Zudaire, María Napal, Irantzu Uriz and G. Enrique Ayuso

Research on learning of genetics have shown that Secondary School students experience difficulties in understanding genetics contents. On this basis, some researchers have highlighted the need of introducing progressively some basic genetic ideas from primary education levels.

Unlike in other countries, Spanish science standards do not include contents related to heredity at primary levels. Therefore, to assess the feasibility of introducing this topic at this stage, we decided first to explore the knowledge of grade 1 to grade 6 students about inheritance prior to the instruction. We designed a questionnaire including 13 questions aligned to the NGSS disciplinary core ideas LS3A (Inheritance of traits) and LS3B (Variation of traits). In this abstract we analyse the findings related to LS3.B core idea in a sample of 514 students. Almost all the students hold the idea that descendants resemble their ancestors. The youngest primary students (6-8 years old) considered that traits in the offspring are identical to their parents'. However, students at higher grades progressively admit the appearance of intermediate traits in the population. Moreover, the idea that both parents contribute to the phenotype of the offspring, and that traits of both may be combined in new ways, emerge from grade 3, showing a moderate association with grade. These results suggest that children already possess some prior understanding that would allow introducing inheritance at primary school.

Time	Thursday, September 1st
16:00-17:30	Paper Session 7C - Students' Conceptions and Conceptual Change
Location:	Building: XΩΔ01, Room: 108
Chair:	

Students' misconceptions about respiratory processes using students' animations

Ana Valdmann and Hedy Suurmets

Enhancing different competences is essential in today's schools; teachers and students are expected to use different information and communication technologies. In this study, students created animations about the breathing process using the slowmation method. The main objective of the study was to identify the misconceptions 9th grade students have about the breathing process and how these change during the creation of animations. The study consisted of three phases: a pre-test, an analysis of the animations produced by the students and a post-test. The results of the tests showed that students' subject knowledge and research skills developed credibly during the animation process. The use of the Slowmation method helps to identify misconceptions in students, but at the same time is exciting and motivates students to learn.

Friends or foes? Microorganisms in Greek school textbooks

Georgios Ampatzidis and Anastasia Armeni

A thorough understanding of microorganisms is considered essential in order for students to understand their importance in biological systems and increasing use in industry and technology. However, research shows that the vast majority of students conceptualize them solely as dangerous and harmful. It has been argued that education should emphasize on the importance that microorganisms have in human lives and their role in the ecosystem and industry; a conceptual change to a representation of microorganisms that integrates their diversity and beneficial contributions seems an essential goal for science education. Considering the fact that science textbooks determine largely what is learned about science in classroom, in this paper we explore Greek science textbooks in regards to the representation of microorganisms. Twelve textbooks currently in use were investigated. Paragraphs mentioning microbes or microorganisms (187) were coded by both authors with satisfactory inter-rater agreement in mutually exclusive categories. Analysis results show that in most cases microorganisms are mentioned in relation to health – e.g. diseases caused by pathogenic microorganisms and ways to prevent them – while, on the contrary, few paragraphs mention microorganisms' role in food production – i.e. wine, bread and yoghurt production. We discuss certain actions to be taken concerning textbooks in order to advance students' understanding of microorganisms such as (a) shifting the microorganism discourse from the human being to presenting them as living organisms in their own right (b) focusing on their role to several branches of production and industry, and (c) encouraging a better understanding of their positive role in ecosystems.

Do bacteria really exist? Learning about micro-organisms in primary school

Zélia Anastácio and Catarina Gonçalves

The approach of micro-organisms is unusual in the early years, as it is not an explicit subject in the Portuguese curricula for primary school. However, the theme of micro-organisms can be explored in primary school through experimental teaching in order to promote the conceptual evolution of children and to demystify the idea that all bacteria are harmful to our health. The aims of this work were to recognise the existence of bacteria; identify bacteria as living beings; recognise their usefulness and function in the ecosystem and health; and finally recognise that bacteria are essential for life on Earth. The research question was: Do bacteria really exist? The methodology used was action research. The sample included a group of 24 children aged between 6 and 7 years old, attending the 1st year of the primary school. The sequence of activities about micro-organisms lasted five days and was divided into two parts: experimental activities for collecting and growing bacteria and build a composting centre; children observation and recorded the results and drew their conclusions. Observations and

learning were recorded through pictures and argumentative dialogues between the trainee teacher and the children. In addition to the records a final argumentative dialogue evidence children conceptual evolution when they said for example that in the beginning they did not see bacteria but at the end they could see many bacteria. Children constructed clearer and scientifically accepted conceptions, recognising the existence of bacteria and identifying them as living beings, contributing positively for life, health and planet.

Investigating how students move between different levels of biological organization when interpreting epigenetic representations

Annika Thyberg, Konrad Schönborn and Niklas Gericke

This study explores how visual representations can enhance students' interpretation of epigenetic phenomena at different levels of biological organisation. Visualizations are a powerful tool for communicating complex biological processes invisible to the naked eye. Using visualizations to develop knowledge between and across different levels of organization can help provide a coherent biological understanding. We use the yo-yo strategy, previously developed in genetics education, to inform interview tasks to probe students' interpretation of visualizations representing epigenetic processes at sub micro, micro and macro levels of biological organization. Epigenetics is a rapidly expanding area of the life sciences with significant societal implications. Epigenetics explains how environmental factors at macro level can influence gene activity at micro and sub micro levels, and thereby human characteristics such as health and disease development. In further investigating how students move between different levels, this study explores how students interpret different visualizations that communicate epigenetic phenomena. Filmed sessions with five focus groups comprising two to four students made up the reported data collection. Analysis of students' pointing gestures and indications toward pictorial features and accompanying verbally uttered reasoning, showed that students move between levels of organization in three distinct patterns. These patterns are: showing no movement (dwelling), one- and two level movement. In addition, five different characteristics of interaction with the visualizations were found that enabled students meaning making of epigenetics between levels: horizontal and vertical comparisons, salient features, analogous connections, everyday life experience and text elements. Implications for biology educational research and teaching are discussed.

19:30	Conference Dinner - Social Event
Location:	Vintage Wine Bar & Bistro

Time	Friday, September 2nd
09:00-10:00	Keynote 2
Location:	Building: XΩΔ02, Room: B205
Chair:	Marianna Kalaitzidaki

Using Physical and Virtual labs for Experimentation in STE(A)M Education: From Theory and Research to Practice

Zacharias C. Zacharia

The focus of this talk is on the contribution that physical or virtual labs makes to students' STE(A)M learning. Both theoretical perspectives and empirical evidence are presented. The theoretical perspectives were drawn from two types of theories, namely embodied cognition and additional (touch) sensory channel. The empirical evidence was drawn from two different lines of research. The first line of research involves studies that have focused on comparing physical and virtual labs (without the provision of haptic feedback), whereas the second involves studies that have focused on comparing virtual labs with and without the provision of haptic sensory feedback. The ultimate goal is to understand when to use physical and/or virtual labs in STE(A)M learning contexts, both from a theoretical and an empirical perspective. The talk concludes with suggestions for future research.

10:00-10:30	Coffee Break
Location:	1 st floor balcony

Time	Friday, September 2nd
10:30-12:30	Parallel Paper Session 8
	Paper Session 8A - Students' conceptions and conceptual change; Students' Interests and Motivation.
Location:	Building: XΩΔ01, Room: 108
Chair:	Andreas Ch. Hadjichambis

Biology teachers' self-efficacy and ability to diagnose and deal with student conceptions

Tim Hartelt, Helge Martens and Nina Minkley

Although it has been proposed that teachers' self-efficacy is related to teachers' actions in classroom and relatively stable once established, these aspects remain a topic of debate as research has produced different results. Many studies measure self-efficacy at a general level. However, self-efficacy is domain-specific and may differ from one domain to another. One important domain relevant for teaching biology is knowing how to diagnose and deal with alternative student conceptions appropriately. Thus, our study investigated to what extent teachers' self-efficacy regarding diagnosing and dealing with student conceptions changes with professional experience and to what extent it correlates with their ability. Therefore, 182 biology teachers (pre-service, in practical training, in-service) were surveyed using a questionnaire and were asked to report their self-efficacy beliefs. Moreover, they were confronted with students' explanations of evolutionary phenomena, most of them based on common alternative student conceptions, such as anthropomorphism, teleology, and essentialism. We found that the participants' self-efficacy correlated with their professional experience and differed between participants with and without teaching experience in evolution. Furthermore, the participants' self-efficacy was positively related to the number of correctly diagnosed alternative conceptions. (Prospective) teachers with high self-efficacy were less likely to not respond or to respond in a scientifically incorrect way; however, they were not more likely to address the student conceptions explicitly when responding to the students' explanations. The results implicate that both teachers' abilities and self-efficacy should be promoted, because self-efficacy is related to teachers' actions and self-efficacy is especially low among beginning teachers.

What is "Environmental Citizenship"? A systematic review of the literature on teachers' perceptions

Yiannis Georgiou, Andreas Ch. Hadjichambis and Demetra Hadjichambi

Education for Environmental Citizenship (EEC) has recently started to gain traction at the research field of Environmental Education as well as at a policy-making level. However, this interest is not yet reflected in teachers' practices, while EEC-related interventions taking place in the school classroom are still scant and limited. A plausible hypothesis lies on that teachers' manifest a limited understanding of Environmental Citizenship (EC) and as such, it's challenging for them to integrate the concept in their instruction. To shed light on this hypothesis a systematic literature review, grounded on the PRISMA methodology, was conducted to examine teachers' perceptions of EC. The selected studies (n=16) were published in peer-reviewed journals during the last twenty-five (25) years (1995–2020) and were subjected into a thematic analysis. The thematic findings of this review revealed that teachers' perceptions: (a) manifest a relatively decreased understanding of environmental citizenship, (b) are narrowed down to the local scale, individual dimension and private sphere, (c) affect teaching practices, (d) are multi-dimensional, defined by inter-related components, (e) vary according to teachers' educational/cultural background and personal identity, (f) affect other environmental constructs defining teachers' professional identity, (g) can be enhanced during teacher education, (h) can be also improved during professional development initiatives. These findings bear significant implications for policymakers, researchers, and teacher educators in the field of Environmental Education.

Representations of gene models in Greek educators' conceptions: preliminary findings

Despoina Tsopoglou-Gkina and Penelope Papadopoulou

Genetics, apart from an integral part of modern biology, constitutes a solid branch of secondary and upper education biology curricula. Despite its central role in science education, it is one of the most problematic areas of the curriculum of biology with students facing conceptual difficulties emerging mainly from the complex genetic phenomena and processes in different organizational levels or deficient didactic transformation of scientific knowledge to school science from educators, which is exacerbated by cohesion lacking textbooks. The methodology framework for the present study, developed for textbook analysis, uses the epistemological features for the categorization of the representations of the gene and its functions in biology textbooks, into five historical models: Mendelian model, classical model, biochemical-classical model, neoclassical model and modern model. The purpose of this study is to explore which gene models are represented in biology in-service educators conceptions' in secondary education in Greece. Using content analysis, we analyzed 17 interviews and found that in Greek biology educators conceptions' the epistemological features of the biochemical-classical, classical, and neoclassical models are prevalent, while the Mendelian and modern are limited. Our results coincide with research conducted in Greek biology textbooks, indicating the necessity of including modern concepts in genetics curricula, as research in genetic education reveals that lack of them leads to genetic deterministic views.

Connections of interest - Effects of interdisciplinary education on interest development in biology and PE

Niklas Kramer and Claas Wegner

Interests are strongly positively associated with academic performance. Although promoting interests appears to be important, interest declines over one's school career. To counteract this, problem-based and constructivist approaches have been used to increase the utility value of subjects. Interdisciplinary teaching integrates both methodological approaches and consequently, appears well-suited to promote interest. Therefore, interdisciplinary interventions combining biology and physical education were developed and compared to individual subjects regarding constructivist process characteristics to investigate whether students find interdisciplinary instruction as more constructivist. Furthermore, situational interest and the utility value of biology were examined. First, two preliminary studies (N1=75, N2=73) consisting of out-of-school workshops showed that interdisciplinary instruction was rated significantly higher in terms of constructive process characteristics compared to biology. In addition, situational interest in biology increased significantly and the utility value of biology was rated significantly higher after the interventions. Second, the main study examined interdisciplinary approaches implemented during instructional time (n=145) compared to a control group (n=84) and was supplemented with a follow-up survey to explore long-term effects of interest development. Survey results will be available in February 2022 and will investigate constructivist process characteristics and their effects on interest development. These findings will be compared to the first two surveys and discussed to see the extent at which it is reasonable to implement interdisciplinary project phases in schools to promote interests in biology.

The influence of incremental scaffolds during experimentation on the students' motivation in biology lessons

Svea Isabel Kleinert and Matthias Wilde

The implementation of experiments in biology lessons is assumed to foster students' intrinsic motivation. However, experimenting involves various challenges for students' in biology lessons. Therefore, incremental scaffolds as internal differentiating and supportive instruments could be used during experimentation. We conducted a 2-study-design to examine the influence of incremental scaffolds on the students' intrinsic motivation in biology lessons. 100 students (Mage=16.50±0.80 years; 55,2% female) (study 1) and 89 students (Mage=17.19±1.32 years; 57,0% female) (study 2) were taught on the subjects of density (study 1) and germination of plants (study 2) in biology class. Data on the students' motivational regulation and intrinsic motivation were collected. While the MANCOVA for study

1 showed no significant effects of using incremental scaffolds on students' intrinsic motivation in biology lesson, study 2 revealed significant effects of incremental scaffolds on students' perceived competence during experimentation. The results indicated that the regular use of incremental scaffolds might help to foster the students' intrinsic motivation in biology lessons.

HPV-vaccinations from an educational perspective

Mats Lundström

During many years, vaccinations have been the issue for discussion. The debate has focused on the need of vaccinations, pandemics and side effects. This study investigates how pupils perceive a vaccination against HPV that is given in school by the school nurse. The research questions focus on if the pupils mean that the vaccination is followed up by the biology teacher and how the decision-making process about being vaccinated happens. Five focus group interviews among pupils aged 11-12 have been analysed through thematic analysis. The analysis ended up in three themes called connections to education, biological vocabulary and decision-making. The results demonstrate that the vaccinations are not followed up by the biology teacher, that the guardians decide about the vaccination and that it sometimes is difficult for the pupils to use biological concepts connected to the vaccinations. The results can be discussed with focus on Qvortrup's concept human becomings or human beings. In this case the pupils are not seen as mature enough to make this decision about their body and health. The results also raise questions how for example sex education performed by the biology teacher and health information from the school nurse can be developed and be cooperated in the future and thereby become a part of scientific literacy.

Time	Friday, September 2nd
10:30-12:30	Paper Session 8B - Scientific Thinking, Nature of Science and Argumentation
Location:	Building: ΧΩΔ01, Room: 103
Chair:	Clas Olander

It's all about the competencies – Identifying and promoting giftedness in the natural sciences

Maria Sophie Schäfers and Claas Wegner

Natural sciences take on an increasingly central role in preschool education. Biology in particular is highly relevant to the children and of great interest because to them it is so true to life. Therefore, a test instrument was developed based on the CHC theory to determine biological-scientific giftedness in preschool in the project 'anonymized'. This could lead to individualized support adapted to differing abilities, which may have positive long-term effects on later school performance. In the comparative study, presented at ERIDOB 2022, the quality and internal structure of a natural-biological scientific giftedness test were examined using a sample of 69 children aged between four and a half and six and a half years ($m = 44.9\%$) from three different day-care centers. We found that our test meets the quality criteria for standardized test instruments in most analyses and can be used for future surveys. Moreover, an explorative factor analysis does not separate individual ability areas of the subtests regarding an internal structure, but all subtests load on one factor with a variance explanation of 41.17%. The factor can be defined as general natural-biological scientific giftedness. Further studies should use a larger sample size to explore the test structure.

How do high school students and trainee teachers engage with contemporary biological research?

Ralph Levinson, Konstantinos Korfiatis and Stephen Price

Our research identifies the forms of dialogue that support 16-17 year old school students in Cyprus and U.K., and trainee science teachers in Cyprus, in thinking about biological research and how they use their science knowledge in exploring open research problems. Contemporary research problems (somewhat simplified) were presented to school and university groups, six participants each, who were tasked with finding possible solutions. They were asked to suggest mechanisms for a biological phenomenon – in this case, cell separation in forming the embryonic spinal cord - and to devise experiments to provide evidence for their ideas. Experienced researchers took part in the discussion to answer student questions or to prompt them when they became stuck. Analysis of data shows that fruitful discussions have the following features: authoritative scaffolding encouraging elaboration, explanation and use of pupil knowledge; willingness of participants to problematise and revise suggestions; collective elaboration of ideas sufficient to stimulate new research questions. Students drew on knowledge through dialogue which problematised their school knowledge and identified its difficulties in application to a research task. Students' responses to a pre- and post- questionnaire indicates that consideration of the research questions generated the excitement of uncertainty and that those studying a mixture of humanities and science subjects were more proficient at providing evidence-based ideas than those focused solely on science subjects.

Students meaning-making of a representation of the greenhouse effect - 'It is an easy representation, if you understand it'

Clas Olander and Johan Nelson

When biological phenomena are communicated in schools, a variety of modalities are used, and students must navigate in a landscape of representational modes and the notion of multimodal literacy becomes important. In this study is 'literacy' connected to meaning making of a phenomenon (the greenhouse effect) and 'multimodality' refers to modes of communication within a pictorial representation of the phenomena as well as the communication between students when making meaning of the representation (talking, writing, drawing, gesturing etc). As general guidance we make use of the pragmatist Peirce's

triadic model. The model focuses the relationship between an object (the greenhouse effect), a representation and the meaning made by the students. The latter forms the aim of this study “what meaning is made by 14-year-old students in relation to a pictorial representation”. Data was generated in three classrooms during ordinary biology teaching where 74 students (14-year-old) participated working in 33 groups who all handed in written interpretations. We also asked (and got) permission of audiotaping all groups and videotaping 12 groups when they discussed the assignment. The result show that in relation to arrows the colour yellow and straight arrows is firmly interpreted as connected to the sun while meaning-making of the colour orange and waviness is less articulated and vaguely connected to heat. The representation as a whole seems to function best as scaffolder for students with more previous knowledge and one group said: ‘It is an easy representation, if you understand it’.

Use of external representations to support biological modelling

Benjamin Stöger and Claudia Nerdel

The best explanatory approaches in biology are based on mathematical models (e.g. population dynamics, biochemical reactions). This illustrates the importance of understanding models and the mathematical modelling in biology. This study focuses on the influence of external representations like texts, diagrams, and images, as well as mathematical expertise, on modelling competence in biology education. Consequently, the participants complete an enzyme kinetics basing on modelling cycles. The thinking aloud method was used to record the learners' cognitive processes. A mixed-methods approach, quantitative frequency analysis and a qualitative analysis of the participants' statements, was used. Elaboration behaviour was found to be increased through representation, as well as expertise. These results indicate the positive influence of external representations and mathematical competence on modelling competence. However, the results also show that the positive influence of additional external representations depends on the mathematical expertise of the participants.

A short intervention that promotes the abstract reasoning scheme improves seventh graders' achievements in the topic of the cell

Reuven Babai and Wisam Bishara

Knowing about the cell structure and function is essential for understanding many biological phenomena and processes. Students are known to have difficulties in the topic of the cell. It was suggested that most of these difficulties may be related to the abstract nature of the cell, i.e., the small size and the different microscopic scales of the cell and its functions. Abstract thinking develops during Piaget's formal operational stage. Therefore, students' low Piagetian cognitive levels could explain such difficulties. We used a short intervention of three sessions that focuses on acceleration of the abstract reasoning scheme, adapted from the CASE program (Cognitive Acceleration through Science Education). We explored the intervention effect on students' achievements. Taking part in the study were 126 seventh graders from six classes. Three classes were randomly chosen to serve as an intervention or control group. A general science exam and a cognitive level assessment test were carried out. After the intervention, the topic of the cell was taught in a similar way in both groups and a post-test exam in the topic of the cell was administered. Findings indicated that the intervention aimed at accelerating the abstract reasoning scheme, had a significant positive effect on students' achievements in the topic of the cell. In line with the study rational, further analysis revealed that the significant benefit of the intervention took place in the pre formal operational Piagetian levels. In sum, we suggest to pay more attention to limitations related to students' cognitive levels.

Using student-created core idea maps to promote meaningful learning in science

Helen Semilariski, Regina Soobard and Miia Rannikmäe

A worldwide concern in science education, seen from a student's perspective, is that learning is perceived as a series of disconnected knowledge acquisitions, which impacts on their interest in science, or promotes a lack of perceived self-efficacy towards their ability in science learning. Core ideas form a unified scientific framework for various topics of the curriculum, as set out in the curriculum and are forming a necessary core for conceptualizing science. Core ideas are important in everyday life and in the future, currently agreed upon by science and society. They can support a perception of interdisciplinarity between science subjects and in so doing, support the development of conceptualizations, which, in turn, makes the learning process more meaningful. The goal of this research is to identify students' ability to use core ideas to form maps to support meaningful learning across science subjects.

Time	Friday, September 2 nd
10:30-12:30	Paper Session 8C - Outdoor and Environmental Education Symposium 4: Revisiting Plant Blindness in Biology Educational Contexts
Location:	Building: XΩΔ01, Room: 109
Chair:	Penelope Papadopoulou

Investigating plant blindness: methodologies, challenges and possibilities

Irma Brkovic, Eva Nyberg and Dawn Sanders

In this symposium presentation, we give an overview of different methodologies applied in empirical research concerning 'plant blindness' and related constructs. We describe, and compare, different methodological approaches to plant blindness and the operationalisation challenges involved in empirical attempts to assess plant blindness as a theoretical construct. We present results from our own research project, in which diverse methods were applied, tapping into different aspects of plant blindness. We discuss our results and question the availability, and usefulness, of existing research tools. We offer a methodology plan for developing new investigations that might close the gap recognised in extant research on the phenomenon known as 'plant blindness'.

Plant blindness intensity throughout the school and university years: a cross-age study

Alexandros Amprazis and Penelope Papadopoulou

Plant blindness refers to the humans' tendency to ignore and underestimate plants, especially in comparison to animals. According to researchers, the educational context is not only one of the causes, but also a main solution to this issue. Considering that, assessing plant blindness' intensity throughout the school and university years can provide valuable clues to design educational intervention programs that will reverse this limited interest in plants. Aim of this study is to assess plant blindness' intensity in Greek student population, to highlight possible correlations between the phenomenon's core elements through a network analysis and to examine how these correlations alter as students move from primary school to university. One thousand two hundred seventy-five Greek students (1275) participated in our study. Their attitudes towards plants were assessed through five-point Likert-type scale items. By following the cross-age studies' principles, certain conclusions were drawn regarding the grade during which the problem is more intense. In particular, the phenomenon seems to be present in all grades, but it seems to be more intense during the high school years. Furthermore, important alterations have been recorded in the phenomenon's core elements' network analysis in each grade. Our findings support the general idea of greater preference in animals than in plants and enhance the concern about the reduced emphasis on plant life in educational systems worldwide. Additionally, the recorded alterations mentioned above probably bring to the limelight the need for a different handling of the phenomenon, accordingly to each educational grade.

How do plants obtain energy? A phenomenographic and pictorial analysis of upper secondary students' conceptions

Oier Pedrera, Oihana Barrutia and José Ramón Díez

Photosynthesis, and plant nutrition in a broad sense, are some of the most indispensable processes in ecosystems and, as such, they are the most prevalent plant-related topics in school curricula of different countries. Nevertheless, students generally leave compulsory education with inaccurate models and a poor conceptualisation level regarding how plants feed. According to the literature, there are several factors contributing to this lack of knowledge. On the one hand, several authors underline that the plant blindness phenomenon that causes people in our culture to become disinterested towards plants also affects the way teachers and students perceive botany-related contents, which consequently provokes these topics to be overlooked or not provided enough time. And, on the other hand, previous research states that plant growth and plant functions are complex topics by themselves since it is necessary to construct robust and coherent knowledge about several underlying key concepts of other disciplines in order to fully grasp them. Acquiring a scientifically accurate model of the plant nutrition phenomenon is not only a desirable intellectual accomplishment, but also a prerequisite in order to be capable of understanding related concepts such as ecosystem functioning and several socioecological issues. Hence, considering that the identification of students' difficulties is the first step towards evidence-informed design and decision making, the purpose of the present research is to explore the explanatory ideas and qualitatively different ways in which upper secondary students reason, about how plants obtain energy.

Promoting students' interest in plants

Amélie Tessartz and Annette Scheersoi

Plants are indispensable for our ecosystems, nevertheless, the interest in plants is low. To describe the state of people neither noticing plants in their environments, nor recognising their importance, the term Plant Blindness has been introduced. As people's interest in nature correlates positively with their willingness to preserve biodiversity, the need to increase students' interest in plants seems to be especially elevated. Thus, the aim of this study was to find out if there are differences in students' interest in relation to different plant groups or species and which factors affect students' interest in plants. Even though questionnaire data (N=501; 10-18 yrs.) confirmed that the interest in plants is low, the data also showed differences between plant groups. The analysis of qualitative data (interviews: N=6; observations in botanical gardens: N>150 people) indicated that, for example, uncommon plants with perceived special features, food plants or especially beautiful plants (e.g. bright flower colour) can influence students' interest in a positive way. Furthermore, the results of our analysis led us to the conclusion that specific activities can foster student's interest in plants: first-hand experiences – especially inquiry-based activities, such as experiments with different types of soil or plants' dissection – stimulated students' interest.

Adult learners' conceptions on plant nutrition and ecosystem services provided

Olga Mayoral, Ana Ruiz and Tatiana Pina

Middle-aged and elderly people represent a relevant fraction of the population and are active agents in our society, yet their possible conceptions on the ecosystem services provided by plants do not receive as much attention in research as that of younger students. The present study assessed the knowledge and misconceptions on plant nutrition and the services provided by plants in a group of 31 adult students attending education university programmes from the Valencian region (Spain). The results showed that most students identified water, sun/light, and soil as the most important needs of plants, whereas only a low fraction of them (19 %) independently recognized CO₂ to be taken up by plants. Even fewer students (13 %) considered CO₂ to be a source of the plant's mass. This lack of understanding makes it very difficult to convey the value of plants as carbon sinks in the atmosphere and therefore their role on possible relevant climate change mitigation and adaptation measures. Regarding what

plants supply, a wide variety of services were named, although only providing fruits and food occurred often (74 %). Other answers include O₂ (45 %), shade, flowers, wood, leaves, CO₂, and beauty. The analysis also concluded that students do not show resistance to the idea that human life is very dependent on vegetal life, although the mechanisms through which this happens were not clearly understood, with gas exchange processes being the great unknown. The detected knowledge gap needs to be filled to increase the social acceptance and the demand for the necessary measures against climate change involving the vegetal world.

Teaching species identification to pre-service teachers in distance field education

Arja Kaasinen and Anttoni Kervinen

Implementing field education in biology teaching is considered challenging by the teachers. This study investigates how pre-service teachers field education, particularly species identification, can be supported through mobile interaction with the teacher educator. In our model developed for distance field education (DFE), preservice teachers performed field tasks in separate field trips while communicating with the teacher educator in a mobile messaging group. Altogether 74 primary school pre-service teachers participated in the study. Data from mobile messages and questionnaires was used to investigate how the participants used a mobile messaging application and how they perceived its use. Messaging application was not mandatory to use, but most of the teacher students used it during the DFE. Teachers students' were able to send or ask any questions, but they tend to ask mostly questions related to species. The participants experienced the use of mobile interaction mostly positively. The most common benefits mentioned were the possibility of getting help, increased sense of community and learning from others. Some mentioned that the communication took focus out of being in nature and making observations. The findings suggest that mobile interaction can be a useful resource for pedagogical support and a way to increase the sense of community in distance field education settings for pre-service teachers. Moreover, this study shows how field education, one of the most demanding parts of biology teaching, can be implemented in distance teaching settings.

12:30-13:00	Closing Session
Location:	Building: XQΔ01, Room: 109
13:00	Lunch
Location	Restaurant A.Zorbas

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EXCURSIONS AT WEDNESDAY AFTERNOON

Guided Tour in the old Nicosia

This guided tour offers a walk with reference to the most noteworthy sights within the walled city of Lefkosa, including the Church of Our Lady Phaneromeni & Phaneromeni school; Tachtakalas neighbourhood; Chryssaliniotitssa Church & Multicraft Centre; Stavros Tou Missirikou (Church converted into a mosque); Municipal Arts Centre (Old Power Station); Famagusta Gate; Venetian Walls; Archaeological Excavation Site.

Total walking distance: Approx. 3 km (The walking route is indicative and may be altered if deemed necessary)

Don't forget to put on some sunscreen cream, comfy shoes, a hat, and bring your bottle of cool water!



Athalassa National Forest Park and Information Centre (guided visit)

Located on the south-eastern edge of the city of Nicosia, almost opposite the university campus, Athalassa National Forest Park is a natural oasis with many endemic and indigenous trees, shrubs and herbs. The Athalassa's Environmental Education and Information Center highlights the various aspects of the environment of the Athalassa National Forest Park. During this tour, participants will get to know the flora and fauna of



Athalassa's wetland and forest ecosystem. They will watch a short film on the fossilized shells of the area and the geological formation of Athalassa's basin and they will observe specimen of the main rocks of Cyprus. They will visit the botanical garden of the centre and they will get to know the rich biodiversity of indigenous, drought-resistant, rare, endemic species of the Cypriot flora as well as the domestic animals of the Cypriot countryside. The visit will end with a relaxing walk in the forest and wetland of Athalassa Park.

Center for Environmental Education and Information “Kavo Greko” (guided visit)

The Center for Environmental Education and Information “Kavo Greko” (Cape Greco) is located at the southeastern tip of Cyprus (90 km from Nicosia), in the heart of the Cape Greco National Forest Park, which is a protected area, part of the European Natura 2000 network. The building is a natural extension of the landscape of Cape Greco, since its materials, colors and textures are harmoniously linked to the natural environment of the area. During the visit to Kavo Greko Environmental Education Center, the participants will have the opportunity to watch a short film about Kavo Greko National Forest Park and its important environmental value. A short tour will be held at the Center’s museum and aquariums which host characteristic specimens of the area’s flora and fauna, including a fossilized skeleton of the Cypriot dwarf hippo. Finally, the participants will enjoy a relaxed walk around some popular natural sights of the Kavo Greko area.



Riverland Bio Farm – Adventure in Nature

Riverland Bio Farm is located in the village of Kambia (39km from Nicosia) and is a farm of organic farming, production of organic products and many recreational activities. Riverland integrates cultural, biological and mechanical agricultural practices that foster cycling of resources, promote ecological balance, and conserve biodiversity.



Riverland adventure is the new way of discovering the farm and its products. Visitors can enjoy an afternoon in nature, introducing themselves to traditional agricultural practises (milking goats, making halloumi and baking traditional pies), hiking in the gorge and in the farm area, and tasting homemade traditional Cypriot products.

INTERNET ACCESS

During the conference you will have free access to internet. Eduroam is available at University of Cyprus. You will have access using your university username and password.

At University of Cyprus you can also have free access using the network “Ucy Guest”. Keep in mind that you must accept “Terms & Conditions”.

UNIVERSITY LIBRARY

Participants who would like to visit the University Library can ask the local organizing committee for an access card. The card is valid for all the days of the conference, but a deposit of 12 euros is required. Once the card is returned, the amount is refunded. In case the card is not returned, it is deactivated and the deposit is used to replace it.

LUNCH

Inside your Conference Bag you will find four vouchers (food coupons) to use for having lunch to the Zorbas Restaurant in the University Campus. Each coupon corresponds to purchase of 6 euro. If your purchases exceed the specific amount, you need to pay the extra cost.

LOCAL TRANSPORTATION

- **ERIDOB2022 Shuttle Bus**

- There will be a shuttlebus service connecting the centre of the city (where most hotels are located) with the conference venue.
- Use the QR code to find detailed information.



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- **City Buses**

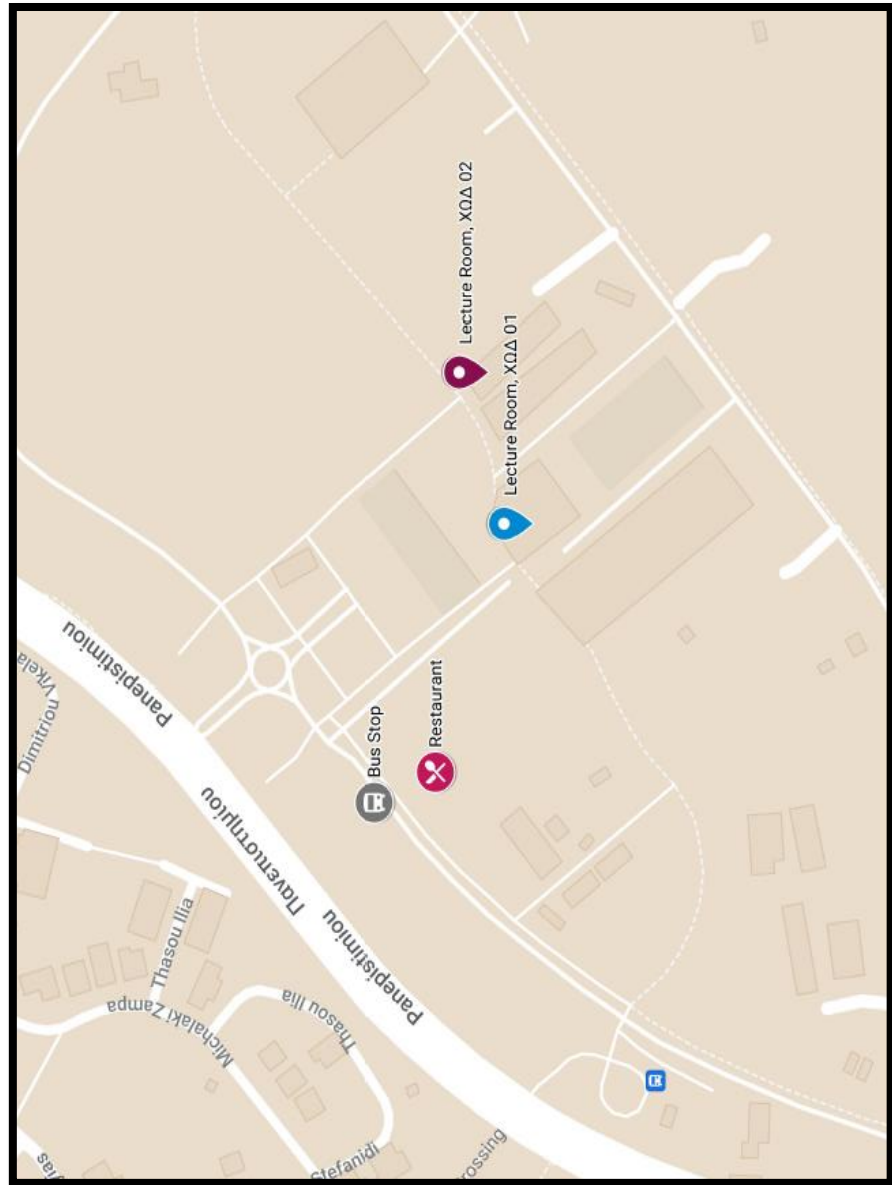
- If you would like to use city buses for your transportation to and from the conference venue, you can find information about the routes, timetable, daily or weekly tickets to the following websites:
- <https://www.publictransport.com.cy/routes/page/routes-and-timetables>
- <https://www.publictransport.com.cy/cms/page/new-ticketing-policy>
- Keep in mind that three stops are important for you: University of Cyprus (Conference Venue), Dionisiou Solomou Square (City Center) and Eleftheria Square.

- You can also move around Nicosia by **bike**.

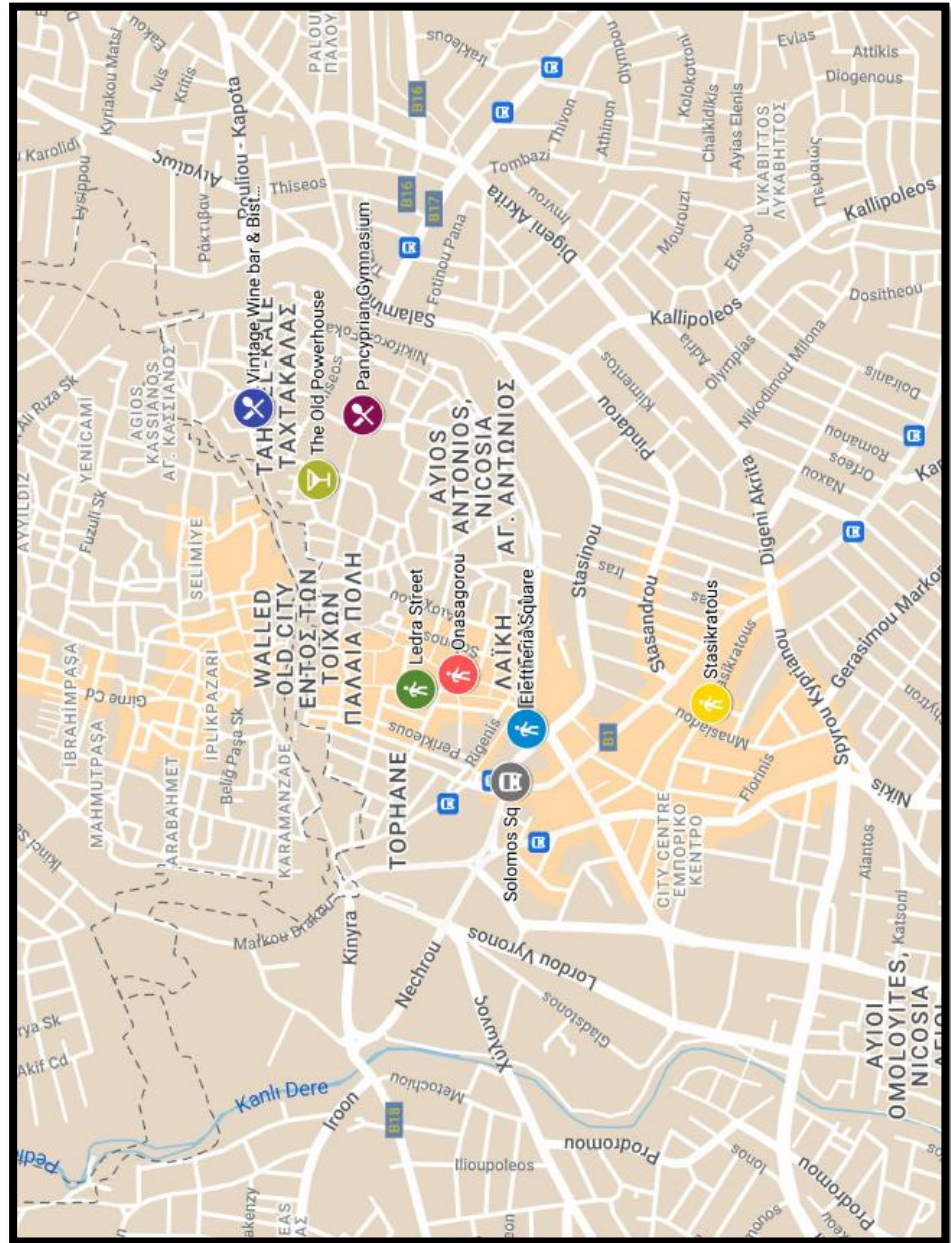
Please visit the website: <https://www.nextbike.com.cy/en/nicosia/information/>

MAPS

Conference Venue

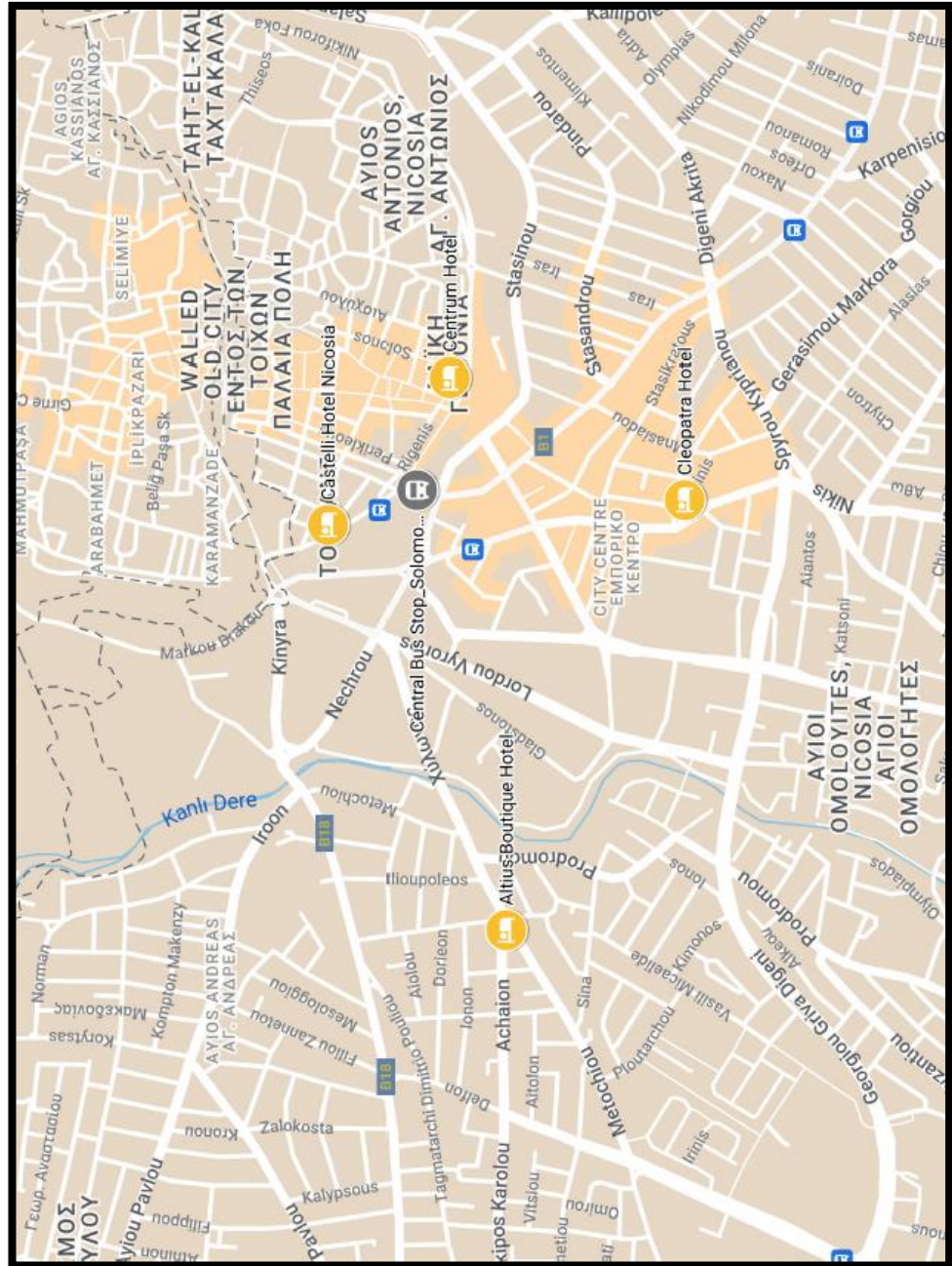


Nicosia City Center



City of Nicosia	
Vintage Wine bar & Bistro Nicosia	
Pancyprian Gymnasium	
Solomos Sq	
Eleftheria Square	
Ledra Street	
Onasagorou	
The Old Powerhouse	
Stasikratous	

Hotels in Nicosia





Eridob 2022



SCAN ME