Focus session
Physics education in the 21st century

Room: Auditorium 6
Session chair: Lesley de Putter (TU/e)

This (interactive) session focuses on educational methods that align with the expectations of and demands faced by physics education in the 21st century. The speakers discuss topics that range from using a playbook for full open-inquiry lab work to in-class discussions of social scientific issues with a background in physics. And from the ins- and outs of Maker Education to using dialogues as an effective tool in the physics classroom.

Open Inquiry playbook for theoretical and practical lab work - active workshop
Dr. Lesley de Putter (Eindhoven University of Technology)
Dr. Forrest Bradbury (Amsterdam University College)
Dr. ir. Paul Logman (Leiden University)

First year physics and general science bachelors are challenged to formulate their own research questions, hypotheses, and experiments in their first lab course, sometimes leading to publishable results (Van Willegen et al., 2020). The workshop aims at providing secondary school physics teachers with a framework to use similar authentic research settings in their classrooms.
After a concise introduction on the lab courses in higher education, the participants start using the playbook "designing open inquiry lab courses" and start brainstorming to create their own practical assignments that stimulate students to formulate their own research question. Scaffolding and must-haves are provided, as well as guidance by experienced physics teachers.

Van Willigen, J., Loman, C., Thibaudier, P., Fokkema, D. B., & Hijmans, T. W. (2020). Uranium fission and plutonium production in the undergraduate lab. *American Journal of Physics*, *88*(3), 200-206

Socio-scientific Issues in Secondary Science/Physics Education
Dr. Dury Bayram *(Eindhoven University of Technology)*
Ilse Maessen *(Eindhoven University of Technology)*

Socio-scientific issues (SSI) are ill-defined problems that are conceptually connected to science (Sadler, 2004). SSI are controversial problems that people would argue about, without necessarily reaching a conclusion or consent (e.g. climate change, diesel cars). Thus, these issues are different from other topics usually presented in science/physics classrooms, especially regarding the uncertainty that they bring with them.
There are ready-to-use materials and tools which help students integrate science knowledge with SSI for evidence-based thinking and reasoning in each context. In this workshop, we will introduce these materials and use one of them in a hands-on way to make you practice an SSI-lesson. At the end of the workshop, you will be able to integrate SSI into your physics lesson.

Maker Education
Dr. Forrest Bradbury (*Amsterdam University College)*
Morten Strømme *(University of Amsterdam)*

Encompassing microcontrollers, modern electronic sensors, and digital design and fabrication technologies, the Maker movement democratizes modern technologies, thereby offering enrichment and enabling innovation in practical physics education. Combined with open inquiry teaching

methods, this accessibility of modern measurement and fabrication tools enhances student agency, motivation, and learning.
This workshop will present concrete examples of incorporating Maker tools in practical bachelor's courses, serving two different purposes:

- Scientific inquiry: Forrest's "Maker Lab" experimental science course utilizes microcontrollers (Arduinos) and electronic sensors (Bradbury & Pols, 2020);
- Design inquiry: Morten's "Biomimicry Prototyping" course employs digital design and fabrication technologies.

We will conclude with an audience discussion of various use-cases of Maker tools in physics lab courses, and the pre-requisite knowledge and skills required of students and teachers.

Bradbury, F. R., & Pols, C. F. J. (2020). A pandemic-resilient open-inquiry physical science lab course which leverages the Maker movement. Electronic Journal for Research in Science and Mathematics Education, 24 (3). *https://ejrsme.icrsme.com/article/view/20416*

Dialogues in the physics classroom. Creating Tools for effective dialogues

Patrick Diepenbroek *(Eindhoven University of Technology)*
Prof. Jan van der Veen *(Eindhoven University of Technology)*

Dialogues are important for learning *if* done correctly. But what is 'correctly'? Literature suggests that teachers play a pivotal role in ensuring that dialogues are happening in the classroom (e.g., Hennessy et al., 2021). Yet, research suggests that teachers have difficulties in ensuring that dialogues are effective (e.g., Vrikki & Evagorou, 2023).
During this interactive workshop, we will collaboratively identify boundary conditions for effective dialogues. We will also be creating tools and strategies for initiating and sustaining dialogues in the physics classroom. By learning *with* and *from* each other, we will all take away tools and strategies for effective dialogues – tools and strategies that we can use in our secondary-school physics classroom the very next day.

Sara Hennessy, Elisa Calcagni, Alvin Leung & Neil Mercer (2023) An analysis of the forms of teacher-student dialogue that are most productive for learning, Language and Education, 37(2), 186-211. https://doi.org/10.1080/09500782.2021.1956943
Vrikki, M., & Evagorou, M. (2023). An analysis of teacher questioning practices in dialogic lessons. International Journal of Educational Research, 117, 102-107. https://doi.org/10.1016/j.ijer.2022.102107