Magdalena’s short blurbs for the PER homepage

# Einsteinian physics education

From the big bang to black holes, from climate change to the science that underpins modern technology, our knowledge of the world builds on Einsteinian physics. Einsteinian physics is based on two major theories of physics: special and general relativity, which describe space, time, and gravity at the cosmic scale, and quantum physics which describes the interactions of matter and radiation at scales down to the smallest subatomic particles.

In the PER group, we develop learning resources and study learning processes in Einsteinian physics across K12. Our activities are part of the international Einsteinian Physics Education Research (EPER) Collaboration, and we work with the [Einstein-First project](https://www.einsteinianphysics.com/) in Australia to develop a seamless Einsteinian physics curriculum. Together with the [PER group of CERN](https://per.web.cern.ch/), we also organise the International Modern Physics & Research in Education Seminar Series ([IMPRESS](https://indico.cern.ch/category/15165/)) to give momentum to Einsteinian physics education and increase the visibility of physics education research.

**Examples of research questions**

* How do learners make sense of key concepts of general relativity?
* What characterizes students’ understanding of the rubber sheet analogy of spacetime?
* How does Einsteinian physics influence middle-school girls’ perception of and orientation to physics?

**Examples of publications**

Kersting, M., Henriksen, E. K., Bøe, M. V., & Angell, C. (2018). General relativity in upper secondary school: Design and evaluation of an online learning environment using the model of educational reconstruction. *Physical Review Physics Education Research*, *14*(1), 010130. <https://doi.org/10.1103/PhysRevPhysEducRes.14.010130>

Kersting, M., Schrocker, G., & Papantoniou, S. (2021). ‘I loved exploring a new dimension of reality’ – a case study of middle-school girls encountering Einsteinian physics in the classroom. *International Journal of Science Education*, 1–21. <https://doi.org/10.1080/09500693.2021.1950943>

Kersting, M., & Blair, D. (2021). *Teaching Einsteinian Physics in Schools: An Essential Guide for Teachers in Training and Practice* (1st ed.). Routledge. <https://doi.org/10.4324/9781003161721>

# Technology-enhanced physics education

Technology shapes the lives of learners and has become a means to experience and understand the world. From computer simulations and extended reality learning environments to shared virtual spaces and teaching platforms, technologies open exciting opportunities to enrich how we teach and learn physics.

In the PER group, we study the educational potential of emerging technologies and develop practical and innovative learning designs that make physics concepts experienceable, relevant and meaningful for learners.

**Examples of research questions**

* How do learners experience and engage with a virtual reality tour of the solar system at a science festival?
* What are design principles for extended reality experiences in (in)formal physics and astronomy education?
* How can we visualise gravity in general relativity through an interactive simulation?

**Examples of publications**

Kersting, M., Steier, R., & Venville, G. (2021). Exploring participant engagement during an astrophysics virtual reality experience at a science festival. *International Journal of Science Education, Part B*, *11*(1), 17–34. <https://doi.org/10.1080/21548455.2020.1857458>

Kersting, M. (2019). Free fall in curved spacetime—How to visualise gravity in general relativity. *Physics Education*, *54*(3), 035008. <https://dx.doi.org/10.1088/1361-6552/ab08f5>

Steier, R., Kersting, M., & Silseth, K. (2019). Imagining with improvised representations in CSCL environments. *International Journal of Computer-Supported Collaborative Learning*, *14*(1), 109–136. <https://doi.org/10.1007/s11412-019-09295-1>

# Embodied cognition in physics education

There is growing agreement among physics educators that learners understand, experience, and study the world through and with their bodies. For example, gestures and kinaesthetic activities can promote the learning of classical mechanics because gestures provide sensorimotor information that prompts idea construction. Besides, learners often project patterns of sensorimotor experiences onto more abstract domains to make sense of physics concepts that are far removed from our sensory capabilities.

In the PER group, we venture outside of narrowly understood views of cognition to advance and enrich our understanding of embodied physics education. A greater appreciation of the embodied mechanisms of physics learning can improve instructional practices and make physics more accessible to a broader range of students.

**Examples of research questions**

* What is the role of the body in physics education?
* How does embodiment enable and restrict students' abilities to think scientifically?
* What imaginative activities do students engage with to communicate and make meaning with abstract scientific concepts?

**Examples of publications**

Steier, R., & Kersting, M. (2019). Metaimagining and Embodied Conceptions of Spacetime. *Cognition and Instruction*, *37*(2), 145–168. <https://doi.org/10.1080/07370008.2019.1580711>

Kersting, M., & Steier, R. (2018). Understanding curved spacetime—The role of the rubber sheet analogy in learning general relativity. *Science & Education*, *27*(7), 593–623. <https://doi.org/10.1007/s11191-018-9997-4>

Kersting, M., Haglund, J., & Steier, R. (2021). A Growing Body of Knowledge: On Four Different Senses of Embodiment in Science Education. *Science & Education*. <https://doi.org/10.1007/s11191-021-00232-z>