

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

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

Introduction

Since the 1950s, PER studies have shown that students often deeply ingrain intuitive beliefs and conceptions regarding natural processes [1]. These can affect how they see the world, understand new concepts, and inquire [2]. To show how science is evolving and to provide new instruments to learn science and physics in an enlarged context, mixing knowledge, techniques, and methods from different disciplines should be part of science and education curricula, developing an integrated model of learning and teaching [3]. These interdisciplinary approaches in education bring educators and students to develop new forms of scientific reasoning and toolkits. Learning experiences and skills acquired through interdisciplinary apply physics fundamentals to real-world solutions, connecting the world of research and society [4].

Theoretical Framework

The integration of storytelling with science holds immense promise in education [5]. Research has consistently shown that stories can serve as a powerful tool to help students reflect on scientific concepts and the evolution of science [6]. This approach not only enhances teaching and students' learning but also promotes peer interaction and fosters the development of scientific imagination and creativity [7]. It paves the way for personalized learning styles and cognitive mediation in approaching physics, thereby enhancing students' critical thinking skills, and fostering a sense of curiosity and interest in the subject [8]. Nevertheless, despite experts recognizing its role in education in many contexts, the introduction of storytelling in school is rare. However, as noted in [9], teaching itself is nothing more than an evolved and highly codified form of storytelling.

Research and research questions

For these reasons, the Educational Division of the Physics Department at the University of Cagliari designed an informal learning activity based on storytelling to bring contemporary high-energy physics topics such as black holes and gravitational waves physics topics to high school. Specifically, this work aims to explore the effect of storytelling on students' levels of classroom participation, motivation, and interest in the proposed topics. We also meant to measure their engagement and, most interestingly, their views about the effectiveness of storytelling as a teaching/learning strategy in the science classroom.

Methods and findings

We make an explicit example of implementing our design during an innovative informal learning cycle of activities held along the lines of the Einstein Telescope (ET) [10] outreach program in Sardinia, Italy. Participants were 200 high-school students (16 to 19 years old) from

five schools (scientific, humanities). The activity lasted 1 hour, with the first 20 minutes dedicated to an original monologue written by the author, followed by a 20-minute session to explain gravitational-related contents and ET physics (gravity according to general relativity, black holes, gravitation waves formation and propagation, detection of gravitational waves with ET, cosmology). During the monologue, some poems were used to tell some facts concerning ET physics. The final 20 minutes were for debate. Through a research questionnaire, we measure the efficacy of our methodology on the investigated domains. We collected 76 answers. Results show that our methodology helps introduce students to contemporary physics themes, fostering their interest and learning of such content. Students' level of engagement was high. They were motivated and interested in learning the proposed topics. Using artistic tools such as monologues and poetry raised their interest and motivation. Students from the humanities significantly appreciated the use of poetry and artistic tools more than their scientific peers.

Conclusion

The research can give instructors a methodological tool to encourage them to bring these topics to school. Storytelling can be used as a tool to introduce students to current trends in research, trying to bypass content-related difficulties (both physical and mathematical) but still making them explore our Universe with inquiry and mind-on activities, improving their motivation, curiosity, and interest in physics. Findings suggest that our approach can also help instructors in orientating students towards STEAM (STEM and Arts) careers.

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