

Mars – a target for teachers and science students

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Abstract. An interdisciplinary course about Mars for teachers and science students is presented. The focus of the course is on planning for a journey with humans to the planet Mars. Issues in ethics, morality, rights and obligations, conflict management and human psychology as well as rocket orbits, fuel economy, radiation hazards and knowledge of the solar system are included. Examination of the teacher students include interpretation of the course material for future pedagogical usage.

Keywords. Mars, ethics, didactics, philosophy of space exploration, radiation, Martian landscape, environmental ethics

1. Introduction

A case study is here presented of an interdisciplinary course about Mars for teachers and science students undertaken at the Department of Physics, Gothenburg University. The course in question is titled: Mars- a return trip. The course is given through lectures and teaching in base groups with group supervision. We aim to share the experience of creating an interdisciplinary approach with lecturers spanning physics, geology, radiation physics and philosophy. Issues in ethics, morality, rights and obligations, conflict management and human psychology as well as rocket orbits, fuel economy, radiation hazards and knowledge of the solar system have proven to be a valued and successful initiative for the further training of teachers and science students.

The focus of the course is on planning for a journey with humans to the planet Mars. This provides a great opportunity to package complex societal problems in a physics context. The course is offered with a special sustainability content mark. Future research could be done on the impact of this course on the education in different levels.

2. Landscape, Radiation, Ethics, Didactics, Learning Goals and Examination

Mankind has always had a strong and dependent relationship with the physical landscape. Understanding the physical environment has been crucial for our survival and development. The same will be equally, or more important for Mars where life conditions are much more extreme. We highlight similarities and differences in the geologic processes that have shaped Earth and Mars (Garry & Bleacher 2011). What conditions do the future explorers on Mars have to manage? We then enter the modern era and explore the dynamic Martian landscape of today. Also, by learning to read the landscape we may find locations of shelter such as vast systems of lava tubes, or locations of essential resources such as preserved glacial ice etc (Starr & Muscatello 2020).

A journey to Mars will cause substantially higher personal irradiation than obtained on Earth. The radiation part of the course lectures starts with defining the different radiation types and the biological effects these different types of radiation will cause. Then, the difference between the irradiation on Earth to the elevated irradiation in space and on Mars is described (Hassler *et al.* 2014). Thereafter, it is discussed if this elevated radiation burden can cause acute biological effects, e.g. fatigue, vomiting and death, and late biological effects as cancer induction. Last, possible radiation protection strategies are described and discussed. The philosophy of space exploration consists of philosophical approaches to ethics, presently applied to the topic of Mars exploration and colonization, with environmental ethics (anthropocentric vs ecocentric) and value theory at its core (e.g. Klein 2007). Four main uses of philosophy are distinguished: ethics, aesthetics, cognition and existentialism.

Research has shown that visual representation is an important part for students to be able to create a deeper understanding of concepts as well as context about the material that is taught. Interdisciplinary and complex societal problems have also been shown to be important in science teaching.

After taking the course the students are expected to have gained:

- In-depth knowledge and understanding of Mars as it is today and how the planet has changed during its history.
- Basic knowledge of how a trip to Mars is achieved and general knowledge of how a colonization might be made possible.
- Knowledge concerning ethical questions and challenges regarding planetary colonization and humans in the space environment.

Apart from these skills we require written and oral participation from the student. Since a fraction of the students are teachers looking for further education, they must develop and interpret the course material for own future application. The other students are required to use the course material to write non-fiction and be able to popularize the material for a general audience.

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