CULTURAL AND EDUCATIONAL ASPECTS OF SPACE-EXPLORATION.

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Introduction: Our modern society relies on worldviews that are able to combine the often contrasting areas of the sciences and humanities into a functioning understanding of our world. A complex human endeavor like space-exploration is exemplary for the necessary connections between the different fields of academic thought. Space exploration relies on a multitude of academic disciplines to realize its core research agenda. Without engineering there would be no way into space, without space architecture there might be no place in space for experimentation and without humanist tradition there might be no reason to go and do experimentation. The simple act of placing experiments on a human space mission touches on all these and more academic disciplines.

We suggest an approach to closing the perceived conceptual gap between academic disciplines without having to resort to reciprocal judgement, but based on mutual esteem for the respective disciplines.

One example for this is the concept of biodiversity. The conservation of biodiversity on Earth is an almost universally accepted positive value, still space-agencies across the globe restrict the number of organisms carried into space. While this concept works at the current level of space exploration, the social and ethical debate about deliberate screening of biodiversity has not been held for large scale space missions. Lunar exploration missions can serve as an example in this case and enhance academic interdisciplinarity.

For example, forward contamination protocols within the planetary protection agenda dealing with the problem of possibly introducing earth organisms into other planetary environments are governed by definitions of contamination probabilities. The history and genesis of the underlying number can be ethically (re-)evaluated without resorting to a-priori moral condemnation but rather by opening up the discussion and showing the broad overlap between this technical and scientific question and sociology, ethics, theology, philosophy, policy and law.[1]

A worldview encompassing a bridge between different academic and scientific traditions is vital for a modern and complex global society and we want to emphasize the educational need for new approaches like the above mentioned thought experiments within an inter- and transdisciplinary field like space-exploration to keep such a worldview from falling behind it's possible benefits. The Artemis program gives the perfect opportunity to address these connections within the scope of lunar surface activities.

Educational propositions

A lack of science and technology awareness impairs students in the humanities and social sciences in their participation in the societal discourse about science and technology, even though students express the wish that innovative technology, science and interdependencies with society should be addressed as a topic in their university studies.

Addressing a similar issue has been attempted with the concepts of science literacy and public understanding of science (PUS). Both concepts have been subject to criticism for two reasons. First, they seem to be incompatible with modern theories of learning, because they imply that people should acquire knowledge not as an active choice, but against their particular interests. Second, both models focus on deficiencies and the need to work against ignorance and misunderstanding of the general public [2: 836]. This somewhat arrogant perspective on the complexity of the relationship between public and science is targeted by the term science and technology awareness (STA) that the authors propose. In contrast to Stocklmayr and Gilbert , who introduce a concept of 'public awareness of science and technology', STA is connotated not as a process of constructing personal meaning from experiences [2], but rather as the opposite. Instead of starting with personal interests and experiences, STA as the authors define it, is focussed on enhancing the awareness of the relevance of science and technology for societal questions on a macro level. Based on the understanding of the general interdependency of science, technology and society, students can develop interest in specific topics and skills in acquiring the necessary knowledge. As a result, enhancing STA can build up confidence in taking

part in societal and academic discourses on science and technology issues and thus enable students to help shape the future that they deem desirable for society and for themselves personally.

Closing the gap between students expectations, societal needs and the reality of university education proves difficult, as addressing these topics in university courses in the humanities and social sciences is a complex challenge, as is addressing social sciences and humanities in scientific disciplines. A novel university teaching program based on empirical data has been designed and tested to address this issue [3].

Bridging the gap

In a teaching module developed for a cooperation between students in theology, social work and elementary paedagogy from different German universities, several courses that brought the students together were designed; after the first trial semester, other student groups (some of them international students from the Netherlands, Turkey and France) from diverse disciplines e.g. engineering, informatics, biology, arts or physics were involved in the courses as well. The courses were integrated into the existing curriculum, making them part of the regular structure of the syllabus. The courses, as they have been taught in the past six semesters, share a number of basic principles outlined below; the specific topics and formats vary from example to example:

1. The basic issue of the courses was science and technology and society. Every specific course focused on different aspects of space exploration related issues;
2. the courses are strongly based on exploratory **students' projects and presentation**;
3. every course was **interdisciplinary** as to the students and university teachers involved;
4. every course involved at least two **different universities**;
5. parts of every course took place in **special environments:** a conference setting, a summer school or a multi-day international workshop at a European research center;
6. the courses involved renowned **experts** from scientific and technological fields, e.g. robotics, astrophysics, informatics, but also visual arts, environmental studies and science education;
7. the pedagogical tool of the **thought experiment** was an essential part in the design of the courses.

The courses involve visits to lectures from interdisciplinary experts at VU Amsterdam, lectures from experts at Brown University, UCSB, ISU and workshops at ESTEC in Noordwijk, NL. The students work in international and interdisciplinary groups on different projects and present their work in front of experts and students in the inspiring context of a place dedicated to space exploration.

In summary, the courses covered basic theoretical approaches combined with a broad range of scientific and technological innovations mostly centered on space exploration. The students got involved in creative work, using thought experiments in order to develop interest and understanding for the connections between technological development and societal issues. Seeing experts from different fields at work and in interaction, having discussions with other students and university teachers and cooperating on joint projects help the students to gain confidence and skills to take part in academic and societal discourses on science and technology topics. Instead of specialized skills and knowledge, the students acquired the necessary, basic understanding of what specialists are working on, what we might be facing in the future and how technologies will change the society we live in, but also how society can influence the development of technologies and science and who the stakeholders in this process are. Expanding the scope of the framework of these courses to future lunar exploration scenarios within the Artemis Program will serve informing future educators, scientists and humanists about the role lunar exploration can have in shaping the future of society.

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