



Sustainability in Academia – Series of lectures at the Department of Astrophysics of the University of Vienna

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This article discusses the design and implementation of the elective course Sustainability in Academia at the University of Vienna. The course, part of the new astronomy curriculum, focuses on understanding and reflecting on ways to make higher education and research - in particular, astrophysical research – more sustainable. Through interactive lectures, quizzes, and a Model United Nations (MUN) debate, students were actively engaged in discussions and in brainstorming solutions that could be applied to academia to face one of the greatest challenges of humankind, the ecological and social crisis.



1 Context

Education shapes the minds of the future. It instills values, thoughts, and methods in students, providing them with tools to comprehend the world in which they grow. As the forestry engineer Baba Dioum said: "in the end we will conserve only what we love, we will love only what we understand, and we will understand only what we are taught". With this in mind and with the strong conviction that, regardless of their field of study, students can make a change, I created an elective course named *Sustainability in Academia*. The course is offered to Bachelor and Master students at the Department of Astrophysics of the University of Vienna, as part of the newly updated astronomy curriculum, which started in September 2023, and requires that students earn European Credit Transfer and Accumulation System (ECTS) points for a module called *Science and Society*. Courses in such module address topics that include gender equality, diversity, climate change, and sustainability.

The series of lectures on Sustainability in Academia took place from October 2023 to January 2024, with six lectures of 90 minutes each. Fifteen students followed the course. They were graded based on their participation (40%) and on a final assessment (60%, see Sect. 4). The learning objectives were the following:

1. Explain the concept of sustainability and the state of climate change.
2. Discuss the different issues regarding sustainability in academia.
3. Propose, evaluate and prioritise solutions to improve sustainability in academia.
4. Debate and defend a position and form compromises.

2 Course syllabus

The lecture series is divided into six sessions. Due to the limited amount of hours - nine hours in total - for this class, only a very general introduction on sustainability is provided to students. The first introductory lecture gives students a basic understanding on the state of climate change and defined key concepts and resources such as sustainability, the sustainable development goals, the three pillars of sustainability (ecology, society, and economy), the International Panel on Climate Change (IPCC) reports¹ and the state of climate change. The planetary boundaries (Rockström *et al.*, 2009) and the doughnut economics (Raworth, 2017) are also presented, the latest being a sustainable alternative to the classical vision of the economy. Based on the definition from the United Nations Brundtland Commission that sustainability is "meeting the needs of the present without compromising the ability of future generations to meet their own needs"², students were asked to reflect in

pairs on which parts of academia are sustainable and which are not. The last part of the lecture was dedicated to discussing their answers.

Through the course, academia was defined as: "Teaching, studying, and scientific work that occurs in colleges and universities", therefore the following two lectures were devoted, respectively, to higher education (emphasizing teaching and studying) and to sustainability in research.

In the second lecture, I presented the current worldwide access to higher education using interactive maps from Ritchie *et al.* (2023), also available online³. I introduced the notion of carbon footprint, and the different sectors contributing to it at a university level (Helmert *et al.*, 2021; Berné *et al.*, 2022). Afterwards, I highlighted the challenges of higher education transformation. On the one hand, universities must adapt to external pressures and expectations arising from heightened competition, accreditation requirements, funding considerations, and more. On the other hand, simultaneously, they have to be accountable to society, generating public value for both present and future students, as well as other stakeholders (Argento *et al.*, 2020; Žalėnienė & Pereira, 2021), creating an apparent conflict and inertia in the transition. Finally, I emphasized the role of teaching in creating the next generation of leaders and empowering students into action, using resources from UNESCO⁴. The last part of the lecture was dedicated to allow students to reflect on their values, and to the case study detailed in Section 3.

In the third lecture tackling sustainability in research, I delved into the carbon footprint of astrophysical research (Jahnke *et al.*, 2020; Martin *et al.*, 2022; Knödlseider *et al.*, 2022; Knödlseider, 2024). I particularly emphasized the contribution of mobility, and the correlation between CO₂ emissions from flights and the academic position of travelers (Stevens *et al.*, 2020). We explored the impact of traveling on scientific work and publications (Wynes *et al.*, 2019; Berné *et al.*, 2022). A large part of the lecture was dedicated to discussing the following questions: Should we slow down the pace of new missions? How can we combine astronomy and sustainability?

The fourth lecture was the most crucial in the series. We explored various stakeholders in higher education (Chapleo & Sims, 2010) to offer students insights into potential actors and their roles, placing them at the centre of the transition as key stakeholders. This enabled the students to consider the problem of sustainable transition from various angles. Some of the teaching methods employed in this session have been inspired by the climate fresk workshop⁵ and are presented in Section 3.

The fifth lecture was dedicated to the final assessment, detailed in Section 4.

The content of the last lecture was decided together with students to offer them the chance to go deeper in

1 <https://www.ipcc.ch/about/>

2 <https://www.un.org/en/academic-impact/sustainability/>

3 <https://ourworldindata.org/global-education/>

4 <https://unesdoc.unesco.org/ark:/48223/pf0000246888/>

5 <https://climatefresk.org/>

Table 1. Table summarizing the teaching methods used in the course. The lecture, the teaching method, and the goals are presented in the first, second and third columns respectively.

Lecture	Teaching method	Goals
2. Sustainability in higher education	Self-reflection on personal values: I provided a list of values and asked <i>What do you value most in life?</i> Students had to self-reflect quietly and highlight 10 key values. Case study: a University is reviewing its curriculum with the goal of integrating sustainability principles across all disciplines. This involves revising existing courses and creating new ones focused on environmental, social, and economic sustainability. The initiative aims to prepare students to address global challenges, but it faces resistance from some faculty who argue that it may dilute the depth of traditional subject matter. Students had to reflect in small groups on the following questions, later discussed with the entire class: <i>How do your values align with the integration of sustainability principles into the university curriculum? Should the university prioritize maintaining the depth of traditional disciplines or embrace an interdisciplinary approach to sustainability in the curriculum? Should sustainability courses be mandatory for all Bachelor's degrees, irrespective of the field of study?</i>	Self-awareness – Framework for decision-making – Critical thinking – Communication & collaboration – Decision-making skills
3. Sustainability in research	Using Martin <i>et al.</i> (2022) as starting point, as well as other material discussed during the lecture, I asked the students to quietly reflect on two questions: <i>Should we slow down the pace of new missions? How can we combine astronomy and sustainability?</i> Then, we discussed the answers with the entire class.	Critical thinking & understanding – Problem solving & communication
4. Stakeholders and solutions	Reflection, movement, and visualisation: I provided the students with colorful post-its (one color per stakeholder), asked them to reflect on potential solutions practical for each stakeholder, and to place their post-it on the blackboard, populating the graph “easiness of implementation versus impact”. This method is commonly used in the debriefing part of the climate fresk workshop. Asking the students to stick their post-its on the blackboard brought some movement and helped visualise the various groups of solutions.	Identify stakeholders and their role – Practical problem-solving – Prioritizing – Visual learning
6. Additional topic	Invited speakers: one of the coordinators of the Climate Fresk for Austria, who took part in COP26 in Glasgow and COP27 in Sharm El Sheikh, and a former consultant at the International Atomic Energy Agency, who attended COP28 in Dubai last December, brought insight into the participation at a COP and answered many questions from the students.	Understanding international climate negotiations

some of the topics, and to have a final discussion to close the course. After brainstorming on various ideas, they decided to talk about the latest COP28⁶, which was mentioned several times during the lectures as it took place during the course. Two guest speakers were invited, to present a brief history of COPs, and to talk about their experience attending such conferences, and actively engaging with students.

⁶ The 28th meeting of the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC), which was held in Dubai between 30 November and 13 December 2023.

3 Teaching methods

During the first lecture, I focused on creating a positive course environment, conducive to discussion, to make students feel safe and comfortable to speak up. In general, I tried to apply the 3 H model for teaching *head, heart, hands*. *Head* refers to the cognitive aspect (i.e., how students think), encouraging them to analyse and reflect on an issue. *Heart* refers to the affective aspect, emotions and feelings, how do they feel about a specific task or question. Finally, *hands*

refer to action and practicality. The integration of these three dimensions emphasizes the importance of nurturing not only intellectual growth but also emotional intelligence and the ability to apply acquired knowledge in real-world scenarios.

I aimed for the course to be very interactive. Each session started with a quiz to either introduce the lecture of the day or recap the previous one. This was very useful to engage students from the beginning. In each session, at least 30 minutes were dedicated to discussing a specific question or aspect, guided by the learning objectives, to prepare the students for the final assessment.

Specific teaching methods were used in some of the lectures. They are summarised in Table 1.

4 Assessment

Throughout the course, students had to defend and discuss their position on different questions relating to sustainability. These frequent debates prepared them for the final assessment, which took the format of a Model United Nations (MUN) debate, where I acted as the moderator. Such a format was elected to shift from the usual competition present in debates to a collaboration-oriented mindset, an aspect crucial to tackling the current challenges humanity is facing. The general concept is briefly explained here, and the slides introducing the assessment are available with other resources (see the resources section).

Students formed groups of two or three and selected a country that they would represent during the MUN debate. The goal was to debate two problems:

1. How can higher education in astronomy be made more inclusive and sustainable?
2. How can conference/workshop organizers ensure that participation in astronomy conferences/workshops are inclusive, representative and maintain a minimal carbon footprint?

To help students prepare their arguments I introduced key questions a month in advance. They were instructed to reflect on these questions, as a starting point, and to highlight key measures for global consideration. They handed in their draft proposal before the day of the evaluation. This enabled me, as the moderator of the debate, to read through them and structure the debate. During the debate, which was divided into one round per question, students briefly summarized their solutions, then they engaged in discussions, formed alliances, and collectively agreed on key measures for each problem.

5 Feedback from students

I collected feedback from students after every second lecture, to continuously incorporate their suggestions, and a final feedback form at the end of the course. An effective feedback method involved providing students with post-it notes at the end of the lecture, asking them to write what they liked and

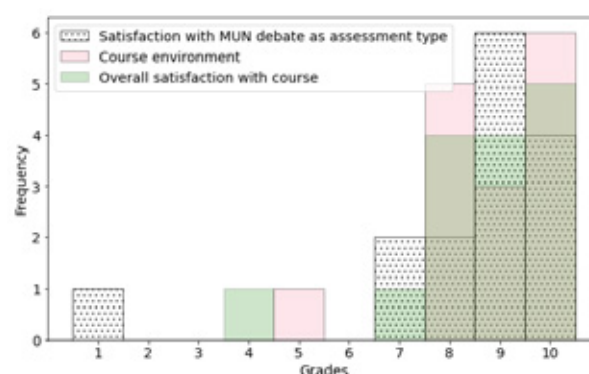


Figure 1. Student feedback on MUN debate assessment format, course environment, and overall course satisfaction, all rated on a scale from 1 to 10.

disliked. They could then anonymously place the post-it notes on the back side of a rotating blackboard. Additionally, a final questionnaire was distributed, asking students to grade specific aspects of the course and provide open-ended comments.

Some of the results are shown in Figure 1. The overall satisfaction with the assessment format, course environment, and the course itself was high, except for one student, who found it challenging to engage in discussions, particularly during the MUN debate.

Students expressed a strong preference for quizzes and discussions during lectures, desiring even more dedicated time for these activities. They gradually increased participation in the discussions through the lecture series, suggesting that such lecture format successfully cultivated critical thinking and favoured an active engagement of the students with the course material. Constructive feedback on the MUN debate included a desire for more diverse countries to be represented and a slightly improved structure and moderation for the debate. The students particularly benefited from the final lecture with external speakers, with whom they actively interacted asking many relevant questions, showing good competence on the course topics and a high interest and motivation in scrutinize them further.

6 Conclusions and outlook

In summary, the course, along with its diverse teaching methods, effectively involved students in discussions, positioning them as active participants in their learning journey. However, it is noteworthy that a few students were less engaged, particularly during the MUN debate; possible ways to enhance their pro-activity and comfort in participation should be addressed. Furthermore, given the demand for more dedicated time for discussions, as expressed by several students, increasing the percentage of lectures dedicated to this purpose from approximately one-third to half or two-thirds could be beneficial. Careful consideration is required to ensure that this adjustment does not compromise the information and knowledge conveyed in the course. Introducing homework assignments,

such as reading articles or watching videos, could be a potential solution to strike the right balance. Encouraging students to take a course on human behavior and impact on the environment, tackling broader concepts such as the biodiversity loss, the emotional and psychological response to the climate crisis, and more, would be a way to provide them with all the background required to adequately understand the issue of sustainability in academia and think of solutions. This could also be done through educational workshops such as the Climate Fresk to avoid overloading a curriculum already busy.

Finally, the resources and teaching methods presented in this article can be used beyond astronomy. In 2024, the course has been extended to include students from different scientific disciplines such as informatics, biology, geography, and cover the broader scope of sustainability in scientific research. More information is available in Fréour (2024).

Resources. Most of the resources used in the lecture series are available in the Google Drive folder: https://drive.google.com/drive/folders/1UWQxW08FxoVp_ZAAdOftrfSj4nUg71uPr?usp=sharing. A ReadMe document introduces the different files available: lecture slides, MUN debate for the evaluation, and results from the MUN debate.

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