

# **From hard facts to opinions - the role of student backgrounds and aspirations in learning outcomes of Climate Change education at the University of Copenhagen**

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## **Motivation**

Studying Climate Change is for many students a choice deeply rooted in their beliefs, viewpoints, and aspirations for the future. This study explores how having completed a course that has a strong focus on the physical basis of Climate Change (the “hard” facts) might have shaped the student’s perception of the topic and whether it contributed to “form” them as reflected citizens in a global change era. The goal of the study was to gather information that can serve as a basis for proposing improvements to the course and the study program as a whole. Specifically, it is intended to achieve a better alignment between the students’ backgrounds and aspirations and the course objectives, since one of the course’s intended learning outcomes (ILOs) is that the students should be able to form informed opinions on societal actions regarding climate change. The study was centered around the following questions: Has getting to know the physics of climate change, and the complex dynamics and interactions of the Earth System made the students more likely to defend climate action and global climate change mitigation measures? And how have the different learning and teaching activities in the classroom, interactions with teachers, TAs, and their peers contributed to that? Do their previous backgrounds play a role in their learning outcomes? Has this course influenced their future career choices significantly? Has it altered the way they discuss climate change topics within and also outside their friend and family circles? Did they benefit

from the wide diversity of backgrounds in the class? To what extent has the course lived up to their expectations, and what could be done in the future to reach a better alignment between the course and the students' backgrounds and aspirations?

## **Introduction – who are the students?**

Students' background and aspirations play a pivotal role in shaping their learning outcomes in higher education. As characteristic to “students of late modernity”, a choice of education is central to how students form and shape their identities (Holmegaard *et al.* 2014). A student's prior experiences, educational history, and professional exposure can significantly influence how they approach academic challenges, engage with course material, and apply theoretical knowledge. Aspirations, whether related to career goals or personal intellectual curiosity, also drive students' motivation and persistence. Thus, knowing who the students are can have a great impact in making teaching more effective and identifying possible gaps between the *implied* student and the *real* student (Johannsen *et al.* 2015).

In essence, understanding the intersection of a student's background and aspirations can provide valuable insights to teachers as students should not only be equipped with knowledge but also supported in defining and achieving their long-term goals. This is particularly relevant for topics such as sustainability and climate change. Some students have a strong sense of urgency and view contributing to solving the ongoing climate change crisis as their most important goal.

“I wanted to study Climate Change because it really stresses me out, to be honest. I have to learn and actually do something about it. Because if I just sit here and think about it, I might just die out of stress. So, I have to, like, learn about it and see how I can make even a really, really, really small change.” Interviewed student #3

## **Brief course description**

The MSc course in *Climate Change Mechanisms and Tipping Points* offers 7.5 ECTS and is available to 30-40 students from four MSc

programmes: Climate Change, Environmental Science, Nature Management, and Physics, with others from related disciplines eligible. Students have varied backgrounds and knowledge of the physical and biogeochemical mechanisms behind Earth's climate variations, which is the course's main theme.

Topics include the planetary energy balance, greenhouse effect, radiative forcing, feedbacks, climate sensitivity, oceanic and atmospheric circulation, cryosphere, sea level changes, plate tectonics, Quaternary climate variability, abrupt climate change, tipping points, and carbon cycle. The course provides an overview of the climate system and recent global warming in a paleoclimatic context, helping students discuss and assess future climate scenarios.

It consists of 20 lectures, theoretical exercises (e.g., glacier mass balance), and student presentations of scientific papers. Students are divided into two groups led by PhD student TAs, with weekly group discussions, lectures, and reading assignments. Course materials are very extensive and include a textbook, about 750 PowerPoint slides, 200 scientific papers, and figures from IPCC reports, alongside additional online resources. Despite the fact that students are exposed to a large volume of course material, about 75% of the students expressed in the course evaluations that the course workload was suitable and teaching materials relevant.

The course's learning outcomes are categorized into three areas: Knowledge, Skills, and Competences.

- **Knowledge** outcomes focus on understanding the basic physics of Earth's climate system, the causes of recent global warming, and knowledge of future climate scenarios. These are described as simpler cognitive processes, aligning with the lower levels (*unistructural* to *multistructural*) of the SOLO (Structure of the Observed Learning Outcome) taxonomy (Biggs and Collins 1982).
- **Skills** involve placing climate change in a temporal context, distinguishing different drivers, and presenting topics in context, aligning with the *relational* level of SOLO taxonomy.
- **Competences** describe more complex outcomes, such as contributing to discussions, critically understanding climate topics, and forming opinions on societal action, corresponding to the *extended abstract* level of SOLO taxonomy.

One key outcome is that students will learn to present a climate change topic in a structured, logical, and scientifically accurate way, supporting engagement with primary literature and disciplinary discourse. Students choose from 15 papers to present either individually or in small groups.

The course final exam consists of an oral test with known questions that are made available 2 weeks before the exam. The oral exam lasts for about 20-25 minutes and the examination questions cover broad topics. The students pick a question, present the topic, and are then asked questions by the course coordinator and an internal examiner (censor). The students can bring all material and notes to the examination (the textbook, the lecture presentations, the additional reading, and the major points of the presented papers).

## Methodology

This study consisted of in-person interviews with a focus group of five international students who had recently completed the MSc course in *Climate Change Mechanisms and Tipping Points* at Copenhagen University. An invitation was sent out to the class and these five participants volunteered to participate. The interviews were conducted during the summer of 2024. The students were interviewed individually for 20-25min. The interviews were recorded and later transcribed (questions listed in Annex 1.)

**Table 1.** Summary educational background information of the interviewed students

Student	Gender	Country of origin	Educational background	Study program at KU
1	Female	Switzerland	BSc in Molecular Biology (Switzerland)	MSc in Environmental Science
2	Male	USA	BSc in Environmental	MSc in Climate Change Impacts,

			and Ecosystem Sciences (USA)	Mitigation, Adaptation
3	Female	Greece	BSc in Environmental Physics (Greece)	MSc in Climate Change Impacts, Mitigation, Adaptation
4	Female	USA	BSc in Environmental Science (USA)	MSc in Climate Change Impacts, Mitigation, Adaptation
5	Female	Germany	BSc in Physics (Germany)	MSc in Earth and Climate Physics

## Interview analyses

During the interviews, students expressed a range of experiences and opinions on how the course impacted their knowledge and helped shape their experience, how the format of the course and the diverse backgrounds in the classroom affected their learning outcomes, and to what extent the course impacted their future education and career choices.

### 1. Impact of new knowledge

The students generally expressed that gaining more knowledge on the topic lead them to feel “*greater confidence*”. They also reflected on the complexity of climate change education, emphasizing that it raises both intellectual and ethical questions. A student observed that there were different levels of “*acceptance*” from their peers and expressed it as “*whether someone fully accepts what is taught to them... or needs a deeper understanding to fully accept it.*”

One student discussed the challenge of retaining detailed knowledge after the course, and noted that, to their surprise, the intensity of learning “*fades over time*”: “*You were so intense for it and then next course, new thing, and you kind of forget... you lose some knowledge again.*” Despite this, they acknowledged that the ability to quickly recall information remains. “*And I think what stayed would be more also the feeling of like, okay, I learned it all. If I quickly read it again, I would know that I would know it, or I can understand it. You know where to find*”

*the knowledge.*" This reveals an interesting perspective of knowledge as something outside the students themselves.

All the students interviewed expressed that the course had a positive impact on how they discuss climate change within their family and friendship circles, as well as with strangers. *"Sometimes people... throw in a weird argument, and you can't really always process it... and answer accordingly because you never considered it before. I think in those situations, the course would have greatly helped me to think about for a minute and come up with a strong explanation."*

In summary, these insights from the interviews indicate that climate change education generally empowers students with knowledge and critical thinking skills that they can apply in real-world discussions, even though they might not be able to retain detailed information for a long time.

## **2. Learning in a group with diverse academic backgrounds**

The diversity in academic backgrounds emerged as both a challenge and a strength. One student appreciated that the course did not force all students to begin from a common ground, allowing those with less background knowledge to catch up independently, so that the starting level of the course didn't have to be too low. Another student reported struggling in the beginning with the course's demand for reading two papers per week, but noticed that their ability to process scientific literature quickly improved *"It was really a steep learning curve"*. In general, the students found that different backgrounds often brought valuable perspectives, but quieter students with unique experiences sometimes went unheard. One of the students pointed out that explaining complex topics in Physics to fellow students with a background in Social Sciences was a very rewarding experience, and that helped reinforce their own understanding: *"...explaining to her a lot of things actually helped me too because you know, if you can explain something in simple words, you actually, get to learn it better, so I wasn't like frustrated by it. I was actually liking it."*

Furthermore, the students engaged in informal discussions outside structured class time. Student #2 explained that most of the interaction took place during breaks and informal settings, which allowed students to discuss class material and exchange ideas freely: *"And so you end up*

*just kind of like having this discussion about what you learned in class over lunch, and you're just throwing balls out, you know, spit balling ideas and what not. So, most of this interaction was informal. It was in the breaks and in between and getting to know each other.”*

While the course aimed to encourage open discussions, several students noted that participation could sometimes be subdued: “In terms of opening your horizons to others, I think it would have been interesting to hear everyone's opinions a little bit more. How everyone's different background influences them. But I think the discussions in class were sometimes a little bit quiet. Just difficult for people to speak up. I think sometimes people were a little bit intimidated by the Physics.”

Overall, the students' reflections reveal a positive attitude towards informal peer learning and active participation, though some challenges remain in fostering inclusive and open discussions. The course's focus on interdisciplinary collaboration was appreciated, but there is room for improvement in ensuring all voices and backgrounds are heard.

### **3. Experience with summative feedback (the oral exam)**

A common theme that all interview participants mentioned was the pressure they felt with having an oral exam. Here, it must be noted that all the interviewed students were from abroad and unfamiliar with the Danish educational system and most had never experienced an oral exam before. While they were not discontent with the outcome (final grade) they described the experience as very stressful. This is a point to consider particularly since the course attracts so many international participants.

“It was a lot of questions to prepare for, you know, a lot, and then you also kind of feel like you have to go through every connection just to kind of get that bigger picture. You kind of have to expand yourself and do that. I'd studied probably two weeks before and then I had mock trials with friends, mock exams. But I mean, I was always a very anxious person. And so my mind goes blank sometimes. And sadly, I forgot one thing.”

“It's very stressful to me because I think in an oral exam, you don't have time to think. Like I know that in a written exam, when I know something, I have the time to think about it and think how

I'm going to write it. But in the oral exam, if you forget something or if you're stuck somewhere, you don't have the time to actually think and searching your brain for it. So you get more stressed.”

#### **4. Career choices**

One main theme that emerged during the interview is that students might need better guidance since at this stage the students are actively considering career choices such as the pros and cons of industry versus academia. They express that it would be useful for them to know more about opportunities for final thesis projects and learn from the lived experiences of Climate Change professionals. This study revealed that this is a point for improvement and that should be considered at the level of the program as a whole.

The interviewed students were clearly at different stages in the decision process. Some had already decided what they wanted to work with at a very specific level (e.g. microplastic pollution and sustainability; ice modelling) while for others the course had either steered them away from an interest in research or towards it. Importantly, one student felt let down by the options that were offered.

“As much as I loved this course, I got a little burnt out from it. Just from, you know, having to study and having to kind of go through all these avenues and being like obsessed with understanding the whole picture. It pushed me to become discontent with continuing to just learn. I want a job that you apply all this. Because I've learned so much over the past five years, six years. And so it kind of pushed me in a direction of I want to apply this knowledge in real life rather than continuing to just harbor it and build up my understanding.”

“I'm starting to think, you know, maybe a PhD in something about the Arctic region would be very interesting. So that was the course that like started this thought, but I'm not sure yet what I want to do.”

“I wanted to do adaptation for my work, but there's only one class on it, and there's really one professor. And I think that that was

really a letdown because that was one of the reasons why I chose this program.”

## **Suggestions for improvement**

This study serves two purposes. On the one hand, it provides insights into “who the students are” and on the other hand it serves to identify some avenues for improvement. Based on the interviews, it is suggested that the course could be improved by focusing on the concerns that were raised by the students.

Encourage participation from all students: Implement strategies to ensure quieter or more introvert students feel more comfortable contributing in class discussions. This could include smaller breakout groups, structured discussions where everyone shares their perspective, or assigning facilitators to lead conversations.

Support interdisciplinary learning: Offer more structured activities where students from different academic backgrounds can collaborate. For example, pairing students from different fields for assignments or creating interdisciplinary project teams could help foster deeper learning and exchange of ideas.

Reduce stress around the oral exam: Provide more support for students unfamiliar with the oral exam format, such as offering mock exams or detailed guidance on how to prepare. Additionally, consider integrating a mix of assessment types (e.g., written and oral) to give students different ways to demonstrate their knowledge.

Improve career guidance: Offer more information and resources on career opportunities, including guest lectures or panels with professionals working in climate-related fields, opportunity to interact with potential role models and mentors. This could also include creating a database of thesis project opportunities and connecting students with potential supervisors.

By implementing these improvements, the course could become more engaging, inclusive, and supportive of students' long-term educational and career goals.

## References

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## Annex 1

### Interview questions

1. In what University study program are you currently enrolled?
2. What is your country of origin?
3. What is your former education?
4. What was your motivation to enroll in the course?
5. Has getting to know the physics of climate change, and the complex dynamics and interactions of the Earth System make you more likely to defend climate change mitigation? What about radical climate action?
6. How have the different learning and teaching activities in the classroom, interactions with teachers, TAs, and their peers contributed to that?
7. In what way did your previous experience play a role in your learning outcomes?
8. Has this course influenced your ideas on future career choices?
9. Has it altered the way you discuss climate change topics with friends, family, strangers?
10. Did you benefit from the wide diversity of backgrounds in the class?
11. To what extent has the course lived up to your expectations?
12. What could be done in the future to improve the course or study program?