Climate Change Economics in Higher Education – Experiences and Recommendations

Michael Lüken
Visiting Professor, Doctor of Economics
Zurab Abramishvili
Resident Faculty Professor, Doctor of Economics
Pignatti Norberto
Resident Faculty Professor, Doctor of Economics

Tackling human-made Climate Change is a topic of high societal relevance and became an established branch of environmental economics research. Due to the interdisciplinary structure of the topic, the integration of Climate Change into higher education programs in Economics still lags behind. Online teaching resources such as Massive Open Online Courses (MOOCs) might contribute significantly to overcoming this deficiency. In this paper, we describe the design of a class in "Climate Change Economics" and how we implemented it in a BA program at the International School of Economics at Tbilisi State University (ISET) in Tbilisi (Georgia). Our main focus is the integration of a MOOC on Climate Change and further online material as main teaching resources. Our main conclusion is that the MOOC, supplemented with videos on special topics, is a suitable tool to facilitate an interdisciplinary introduction into Climate Change within an academic class in Economics. The results of our evaluation show that online resources are highly motivational for students and encourage an efficient studying process. Based on our experiences, we offer recommendations for further strengthening Climate Change as a topic in higher education. We provide suggestions on how online resources such as MOOCs might contribute to that aim.

Keywords: *Economic Education and Teaching of Economics (A2), Environmental Economics (Q5), Economics of Climate Change (Q54)*

Introduction. There is a growing interest to integrate the emerging discipline of Climate Change Economics in higher education programs. An economic perspective can make a significant contribution to analyzing the causes and consequences of anthropogenic Climate Change and also to designing efficient solution strategies. However, a natural science-based understanding of Climate Change is an indispensable prerequisite for its economic analysis. For instance, the inertia of the climate system but also the technological and societal transition to carbon-neutrality happens on timescales longer than one investment cycle and exceeds the time horizon of most economic models.

The interdisciplinary nature of the topic is challenging and impedes the integration of Climate Change into academic programs in Economics. A potential solution is to establish a transdisciplinary cooperation with lecturers from other faculties or to find lecturers with a specific interdisciplinary background. With conventional in-class teaching, this is often hard to organize.

Using an interdisciplinary massive open online course (MOOC) has various advantages in this regard. A MOOC is an online course that usually has a large number of participants and no admission restrictions. The production of MOOCs requires significant efforts, but once it is published, a potentially unlimited audience can benefit from it. MOOCs combine video lectures with interactive elements such as virtual discussion groups, and participants are free where and when to study. A main advantage of MOOCs is that they allow for an individual and interactive study process, for example by integrating interactive quizzes. MOOCs receive growing attention in academic education, besides their potential in informal education (Ebner et al., 2020, Kaplan and Haenlein, 2016). Another useful feature of a MOOC is that it can easily feature different lecturers and hence integrate the expertise from various academic disciplines and faculties. This makes

MOOCs very promising to facilitate the teaching of Climate Change as an interdisciplinary topic (Coelho et al., 2015, Otto et al., 2019, Senevirathne et al., 2021).

The main disadvantage of MOOCs is the limitation of social interaction. (In the current pandemic situation, however, any teaching process has to deal with this challenge.) To overcome this drawback, a hybrid approach of combining self-organized, online-based learning and a conventional seminar setting (so-called blended learning) can be useful.

The authors introduced a class in "Climate Change Economics" as an elective class for students in the 2nd to 4th year within the Economics BA program at the International School of Economics at Tbilisi State University, Tbilisi (Georgia). A MOOC served as the main teaching resource to establish a solid interdisciplinary basis for an economic analysis of the topic. Students worked on online material (sequences of teaching videos, most of them about three to five minutes in length) prior to each regular weekly class time, as inspired by the work of Andone and Mihaescu (2018). We implemented the class in Spring and Fall semester 2020. Since Fall Semester 2021, the class is offered on an annual base. In a recent report (Lüken et al., 2021), we have already presented the learning objectives of the class, the semester structure and our approach how to integrate the MOOC in more detail.

For the purpose of evaluation, we elaborated two standardized questionnaires, one at the beginning and the other one by the end of the semester, to assess students' impressions about the MOOC-based learning process and to observe their acquisition of knowledge. 48 students answered the first questionnaire and 36 the second one. Additionally, we performed standardized interviews with five students after the completion of the class.

Results.

Students' motivation and expectations. The success of each learning process is framed by the learner's motivation and expectation. This holds particularly in a formal higher education setting, where students' striving for a degree with a good GPA often plays a dominant role. In the first questionnaire, we asked students about their motivation for choosing the class and found a surprisingly high level of intrinsic motivation: Students rated the statement "I am interested in the topics of the class" with 4,21 out of 5 points on average and "I would like to save the world" with 4,35 out of 5 points. Also, the prospect of using an online-based teaching resource influenced students' choice for the class ("I am curious about the online course (MOOC)": 3,54). The pragmatic motivation to take the class primarily in fulfillment of the degree requirements played a far lower role ("I need the Credit Points / I need another elective class": 2,9).

Regarding their expectations, students gave high rankings to all answer options, especially to options related to their personal life ("getting ideas what you can do in your private life" (4,35), "learning about implications for Georgia" (4,25)), but also to the more academic-related options ("learning about climate science" (4,15), "learning about economic theories and models" (4,13) and "learning about climate policy" (4,04)). One student added the following comment: "Every year Georgia becomes [a] more significant part of global economy (right now it's not that big of a part but we will get there) and as I have decided to use my abilities in the future to help my country, it is interesting to me to know more about climate change economics as it will be crucial in the future of the world."

It can be concluded that students had a strong intrinsic motivation for climate change at the beginning of the semester, related to the expectation to gain academic knowledge as well as practical skills to take action for climate protection in daily life.

Prior experiences with online resources. Students are nowadays very experienced with online-based resources in their daily life. It is hence not a surprise that most students had already often used the internet also for their studies: On a scale from 1 ("never") to 5 ("very often"), 43 out of 48

students answer 3 or more (mean: 3,83). Many students also had already used online courses or online videos (mean: 3,29). The use of online courses or online videos as an official requirement of a class is not so abundant: 13 out of 48 students have never made such an experience before, the mean value is 2,08.

Impressions of the MOOC. After completion of the MOOC, a large number of students rated it positively: 21 out of 36 students gave it 5 points on a scale from 1 to 5, the mean value is 4,42. The teaching videos, as the main input providing element of the MOOC, also receive a positive feedback with a mean of 4,33, and no student rating them in the negative part of the scale (1 or 2 points).

Other features of the MOOC besides the teaching videos (interactive quizzes, discussion board, extra materials such as texts, internet links, further videos) were voluntary. We asked students how often they used these features. The result is a differentiated picture: The quizzes receive higher attention (mean 4,08) than the extra materials (mean 3,08). We explain this by the fact that the quizzes are embedded directly into the mandatory teaching videos. The comprehensive additional material in the MOOC did not attract most students' attention, presumably also because they received additional input in class anyway.

A broad majority of students rate the quizzes as useful or very useful (26 out of 36 answers are 4 or 5 points, mean 3,86). We conclude that students easily detect and then use a feature that is useful for their study process.

The teaching skills of the instructor clearly play a key role in any lecture situation, and this applies to teaching videos of a MOOC as well. In the majority of MOOCs, one expert acts as the instructor in the video material. The MOOC we used is special as it features a broader range of about 20 experts from various climate-related disciplines. The performance of the experts in the videos receives high rankings, in particular their professional competence (mean 4,42) and their comprehensible explanations (mean 4,03). All but one student gave a neutral (3 points) or positive (4 – 5 points) answer. The experts' motivational skills were also acknowledged (mean 3,75).

Knowledge acquisition. We asked students for a self-estimate of their knowledge about specific climate-related topics, assuming that a self-estimate is a viable reference. If students give themselves a higher ranking in the second questionnaire, compared to the first one, we interpret this as knowledge acquisition.

First, we asked about "How do you rate your level of knowledge about Climate Change in general" (see Figure 1). Prior to taking the class, a broad majority of students had rather limited knowledge about the topic. 5 out of 48 students rank their knowledge with 4 points and no student with 5 points. The mean value is 2,71. After finishing the class, the mean value is 3,94, with 28 out of 36 students ranking their knowledge with 4 or 5 points.

We find a similar result for all assessed topics (see Figure 2). In the first questionnaire, mean values range from 3,35 (climate impacts on nature) to 2,0 (climate models). Topics with higher visibility or regular media coverage, such as the causes and impacts of climate change, receive higher values than the rather abstract climatologic topics, such as climate models and paleoclimate. In the second questionnaire, mean values range from 4,31 (causes of climate change) to 3,06 (climate change in the past). In particular, the increase in natural science related topics is remarkable (e.g., climate models: mean value 2,00 at the beginning, 3,53 at the end of the semester).

In total, the class initiated an efficient knowledge acquisition in a wide range of climate change-related topics.

Relevance for future studies and career. In the second questionnaire, we asked students how they evaluate the relevance of the topic for their future. The majority of students affirm the relevance for their future private life (25 out of 36 answers with 4 – 5 points, mean 3,83). This result is remarkable, since we covered the influences of personal lifestyle on the climate (e.g., consumption or dietary choices) only briefly. In connection with the results about motivation and

expectations at the beginning of the class, we have the impression that students understand the relevance of climate change for their daily life and find answers to their questions.

Most students also have a professional interest in climate change, although many of them are rather doubtful about the relevance of the acquainted skills for their further studies and professional future (only 17 out of 36 answers with 4 – 5 points, mean 3,28).

Interview results. The purpose of the interviews with five students was to reflect and complement the results obtained from the questionnaires.

Our first set of questions was: Is the Online Course/MOOC a good tool for learning, and why do you think so? Was the level appropriate as a resource in a BA class? The interviewed students rate the level of the MOOC as appropriate for a BA class. They particularly praise the videos. They highly prefer working on videos over reading texts or static presentation slides. In particular, students highlight that the embedded quizzes and the short duration of each video were useful to maintain focus. One student says she is generally a "fan of online courses", and she also takes courses in her free time. We conclude that the MOOC is a suitable teaching resource and relates well to the "everyday reality" of students. Offering short audiovisual media and interactive methods such as embedded quizzes connect the study process to students' ordinary media consumption.

In our second set of questions, we asked: We skipped some parts of the MOOC, and we changed the order of other parts: How was your impression about that? In the later parts of the semester, we used teaching videos from other sources for economic topics beyond the scope of the MOOC. How was your impression about that? – Students replied that the changed sequence did not confuse them, and adding videos from other sources was merely a "scenery change" and did not impede their learning process. Some students added it would have been nicer to stay on the same online platform, and that they missed the supportive effect of the embedded quizzes. We conclude that the MOOC can be used in a flexible way, not necessarily following the given sequence of lessons.

We then tackled the interdisciplinary approach of the class by asking: Was it clear for you why we spend significant time on the natural science of climate change and on climate policy? Students give positive answers, such as "of course, it is all interlinked", and "to build the house you need the base - first we need knowledge about climate change and then we can interpret it with economics." We conclude that students share our understanding of the relevance of the natural science basics and political framework conditions for the topic.

According to the questionnaires, most class participants were very motivated to learn about climate change, but do not see much relevance for their future studies and career in economics or business. We asked students in the interviews to comment on that. Students confirmed that they see few job opportunities related to climate change economics, since the field is not well developed in Georgia. One student mentioned though that he considers basic knowledge about climate economics as important for his planned business carrier.

Our final set of questions was, how important is climate change for Georgia, and why do you think so? Are people in Georgia aware of the importance, and aware of the solutions? Are the solutions we spoke about in class applicable for Georgia? In the opinion of the interviewed students, the awareness is still limited, because public attention rather focuses on current challenges such as the pandemic and inner politics. Most students express their doubts about the applicability of economic standard solutions in Georgia, such as a tax on greenhouse gas emissions. They point out the following barriers: low public awareness, low-income level, missing capacities in government/administration. Only a few students consider taxation on greenhouse gas as a realistic strategy.

Our conclusions from students' feedback are twofold: First, there is an obvious gap between the importance of economic knowledge about climate change on one hand, and the unavailability of jobs on the other hand. This gap needs to be addressed in the future. Second, the real-world applicability of economic "standard textbook concepts" to countries in transition requires further

research, and the specific situation of countries in transition should receive more attention in education about climate change economics.

Conclusions and Recommendations. This paper contributes to the growing literature about the potentials of MOOCs as a teaching resource in higher education by presenting an evaluation study of a new "Climate Change Economics" class in an Economics BA program. Our particular focus was the potential of MOOCs to facilitate the integration of climate change (as an interdisciplinary topic with high societal relevance) into a degree-awarding Economics program. The main results are as follows:

- Students have high intrinsic motivation for the topic. After completion of the class, most students affirm the relevance of their acquainted knowledge for their private life but not for their future career.
- Although students are very experienced in using online sources for studying, only a few of them worked with online material as a mandatory teaching resource before taking our class.
- A broad majority of students rates their experience with the MOOC positively. This also relates to the teaching of the experts lecturing the MOOC and the didactic element of interactive quizzes within the MOOC. Additional material available in the MOOC received only little attention. This is probably due to the hybrid learning setting that offered students room for discussion and extra input within the weekly class time.
- According to students' self-estimate, their understanding of a broad range of climate-related topics increased strongly. This holds particularly for abstract natural science-based topics such as climate models.

Our main conclusion from these results is the following: The MOOC, supplemented with further videos on special topics, is a suitable teaching resource to facilitate an interdisciplinary introduction into Climate Change within an academic class in Economics, and helpful for lecturers who do not have an academic background in the natural science of Climate Change. We also conclude that online resources are highly motivational for students and encourage an efficient studying process.

There are limitations to the interpretation of our results. Future studies should apply additional methods for measuring knowledge acquisition and include further higher education institutions. However, we are convinced that our approach to implementing a climate-related class in an Economics BA program serves as a promising case example, and we see large potential for similar efforts in other programs and institutions.

We would like to finalize this report by giving the following recommendations:

1. Higher education institutions in Georgia (and other countries in transition) should receive assistance for a sustainable implementation of climate change in their degree programs. Our concept can serve as an example of how to integrate the climate topic into higher education, but there are still barriers against widespread adoption. Future attention should hence be paid to overcome the barriers and to create transferable long-term implementation strategies. Higher education institutions need substantial support to solve this challenging task. The following ideas might contribute to the required capacity building:

- Assessing the potential for transdisciplinary cooperation among faculties and universities (for example: a climatologist and an economist from different universities cooperate to launch a climate change class that fits into both their academic programs).
- Initiating an exchange of experience among academic institutions in Georgia that have already launched or are interested in launching climate change-related classes in their programs, and defining best practices.
- Establishing international cooperation with academic institutions that have already larger

experience in interdisciplinary teaching of climate change, e.g., in EU countries.

2. The potential of online teaching resources to facilitate the inclusion of climate change subjects in academic teaching should be explored far more.

In our experience, the MOOC "Climate Change, Risks and Challenges" makes an excellent foundation for teaching a basic understanding of climate change. However, to foster a widespread implementation of climate change in Economics and social science programs, it would be highly desirable to integrate further economic and political subtopics into the MOOC. Also, additional MOOC lessons on regional topics and applications would be beneficial to better cover the perspective of countries in transition.

With the upcoming release of the IPCC's sixth assessment report and the new developments in international climate policy, initiated by the recent return of the USA into the global climate policy mechanism, we also recommend an update of the MOOC to be produced. The general messages in the current MOOC version, based on the IPCC's Assessment Report 5, are not foreseen to change significantly. However, we believe that academic teaching in such a dynamic field should be based on the most recent scientific knowledge.

3. More attention should be paid to professional perspectives related to climate change in Georgia (and other countries in transition).

We regret that most students passing our class see only the limited relevance of their newly acquainted knowledge for their future studies and career. Providing them with specific information about climate change-related master programs and job opportunities might be beneficial.

Beyond that, students' impressions reveal a fundamental chicken-and-egg problem: On one hand, economic expert knowledge on climate change is currently largely "imported" to Georgia through international cooperation projects and foreign expert visits, due to a lack of domestic expertise. On the other hand, students in Georgia are highly motivated to achieve such expertise but are skeptical about career potentials in that field. Thus, there is clearly a mismatch between demand and supply for human resources with expertise on climate change economics in Georgia.

Establishing climate change-related academic research and education in Georgia – not only project-based but rather on a long-term scale – might be a first step to overcome the chicken-and-egg situation and contribute to a domestic availability of climate change-related, solution-oriented expert capacities in Georgia (and likewise for other countries in transition). The positive effects of such an approach will not emerge overnight, but they provide the foundation for a more successful and sustainable implementation of solutions to climate change in the long term locally and globally.

Figure 1: Students' self-estimate of knowledge about climate change in general before and after taking the class on a scale from 1 (very low) to 5 (very high).

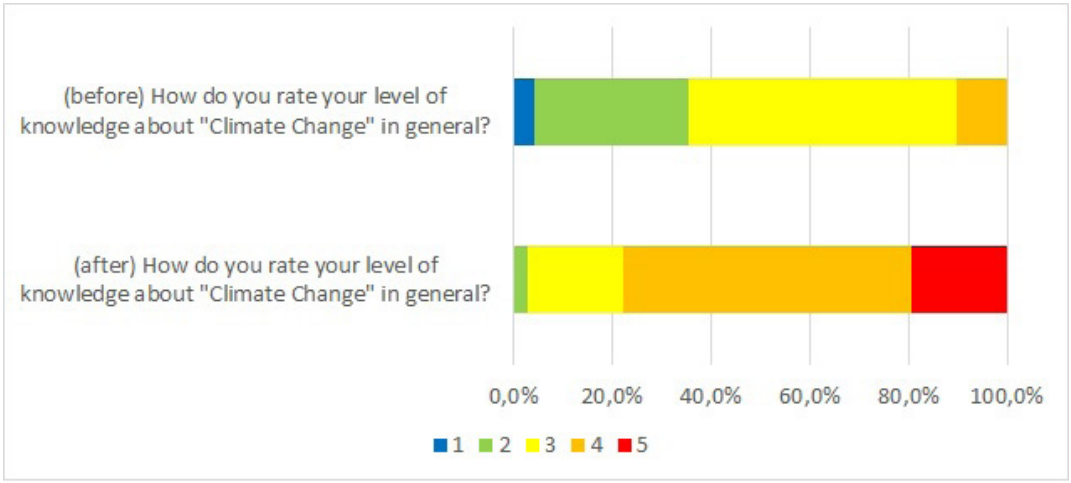
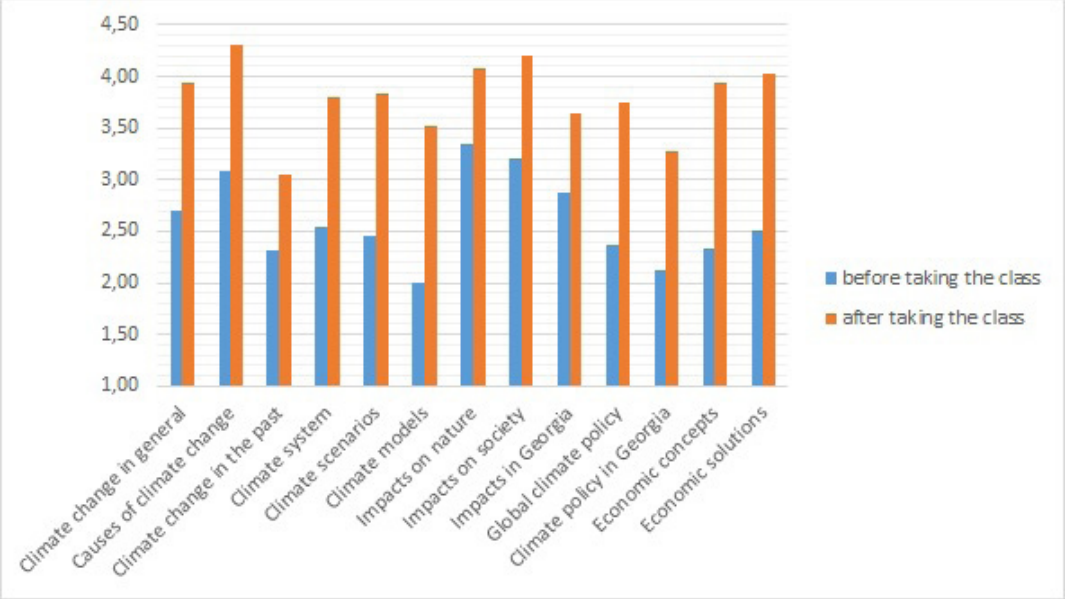


Figure 2: Students' self-estimate of knowledge about climate-related topics before and after taking the class on a scale from 1 (very low) to 5 (very high). Mean values.



References:

1. Andone, D. & Mihaescu, V. (2018). Blending MOOCs into Higher Education Courses - A Case Study. Presented at 2018 Learning with MOOCS Conference, Madrid, 2018. (LWMOOCS), Madrid, Spain, 2018.
2. Coelho, J., Teixeira, A., Nicolau, P., Caeiro, S. & Rocio, V. (2015). iMOOC on Climate Change: Evaluation of a Massive Open Online Learning Pilot Experience. *International Review of Research in Open and Distributed Learning,* 16(6), 152–173.
3. Ebner, M., Schön, S. & Braun, C. (2020). More Than a MOOC - Seven Learning and Teaching Scenarios to Use MOOCs in Higher Education and Beyond. In Yu, S. Ally, M. & Tsinakos, A. (Eds.) *Emerging Technologies and Pedagogies in the Curriculum. Bridging Human and Machine: Future Education with Intelligence* (pp. 75-87). Singapore: Springer.
4. Kaplan, A. M. & Haenlein, M. (2016). Higher education and the digital revolution: About MOOCs, SPOCs, social media, and the Cookie Monster. *Business Horizons*, 59(4), 441-450.
5. Lüken, M., Abramishvili, Z. & Pignatti, N. (2021). Implementing a class in Climate Change Economics: A case study how online resources facilitate interdisciplinarity in higher education. *ISET Working Paper Series*, 04-21.
6. Otto, D., Caeiro, S., Nicolau, P., Disterheft, A., Teixeira, A., Becker, S., Bollmann, A. & Sander, K. (2019). Can MOOCs empower people to critically think about climate change? A learning outcome based comparison of two MOOCs. *Journal of Cleaner Production*, 222, 12-21.
7. Senevirathne, M., Priyankara, H.A.C., Amaratunga, D., Haigh, R., Weerasinghe, N., Nawaratne, C. & Kaklauskas, A. (2021). A capacity needs assessment to integrate MOOC-based climate change education with the higher education institutions in Europe and developing countries in Asia: findings of the focused group survey in PCHEI under the BECK project. *International Journal of Disaster Resilience in the Built Environment*, forthcoming. [Ahead-of-print publication: https://doi.org/10.1108/IJDRBE-07-2020-0074].