Keeping up with Climate Change – Updating the Pedagogy for Teaching Climatology and Climate Science in the Landscape Architecture Program

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Background

There is a need to integrate Climate Change (CC) knowledge into education and training programs. This is the only way that, over the long term, society can manage CC effectively: By understanding the importance of mitigating atmospheric greenhouse gas sources and adapting to CC threats already underway. Our LTV students in Landscape architecture, Landscape engineering, and Horticulture engineering have a particular need for CC related knowledge in their coming vocations, whether in municipal planning, environmental consulting, horticulture or landscape design, engineering or management. Communities throughout Sweden and elsewhere are faced with designing and managing landscapes in the face of the climate change challenge, and climate-aware design and management of vegetation and soils are crucial to this effort.

In order to judge the viability of different approaches to climate change action, a basic understanding of the climate system, and the science behind our understanding of climate change, is needed. Currently, this is addressed at SLU-LTV with an introductory course module on Climatology and Climate Change Science (5 HP equivalent), which makes up the first 2.5 weeks of two courses that I am responsible for – "Climate Change – Landscape in Transition" (LK0412, Masters level) and "Climate Change – Landscape Effects and Potential Solutions" (LK0401, Kandidat level).

This module had been taught in the past in a traditional lecture fashion, with 45 minute lectures on a new topic each day (7 lectures in total in this module), supplemented by readings and followed by group discussion of the topics. This is a science-heavy module, challenging for both teacher and students, because the students have a broad range of backgrounds, with half or more having a landscape ecology background, while a minority have a physical geography, environmental science, or other natural sciences training. Some students thrive while others struggle to keep pace; and this module is important underpinning for later modules addressing sustainability and CC action.

Best Practice Project – Goals and Approach

For this best-practice project, we re-tooled the 2.5-week module on climatology and climate change science, using a flipped classroom approach. In a flipped classroom the lecture material is taken in prior to the respective class meeting (typically using pre-recorded videos or online learning materials), followed by in-class time spent on discussion and active learning via problem sets or other exercises. This places the student at the center of the in-class learning environment, rather than the instructor. This approach also enables students to proceed through the material on their own time at their own pace, for example by pausing and re-watching videos at the sections that need reinforcing. Importantly, the videos should be complemented by active-learning in-class exercises emphasizing higher-order learning. Knowledge and skills are better retained when students actively engage the material (Freeman et al., 2014).

The core goal was to strengthen the students' grasp of basic climate change concepts, their critical thinking skills, and their comfort and skill working directly with the material. Another secondary goal that we had as instructors, was to determine whether the flipped-classroom approach with pre-recorded videos would be accepted by students, and whether it would improve or worsen knowledge uptake and learning of this module, compared to the traditional in-class lecture format.

Implementation

The project was carried out during summer-autumn 2023, and first implemented during period 3 of the 2023-2024 school year. This project involved two staff at the LAPF department: Ishi Buffam, a Senior Lecturer who is Course Responsible for the two courses in question and who developed the material for the lectures; and Kamil Chojnowski, an Adjunct teacher who helped teach the courses in the past as a teaching assistant and (during the pandemic) course administrator. Ishi was responsible for generating course material and project oversight, while Kamil was responsible for the technical work including most of the editing.

To carry out the flipped-classroom approach, we converted material from the traditional lectures in this first 2.5-week module of the course, into video lectures and associated online materials. Through this process, current lectures were broken into shorter mini-lectures of ca. 10-30 minutes and recorded using Zoom, then further edited using Adobe Premiere Pro 2024. We also created a short introduction of about 15 seconds for each video with background music and standard graphics highlighting the SLU logo and branding, using PowerPoint 365. Accompanying each video were links to online help-materials, including existing YouTube videos to help visualize key concepts.

Materials Generated

We created nine new lecture videos. Topics of the videos, in the order in which they are used in the course, include:

- Energy and atmosphere (32 min)
- Carbon cycle overview (8 min)
- Peatlands and the carbon cycle (12 min)
- Global climate zones and weather, part 1 (26 min)
- Global climate zones and weather, part 2 (20 min)
- Intro to mitigation (6 min)
- Climate change and cities (19 min)
- Intro to adaptation 1 (36 min)
- Intro to adaptation 2 (32 min)

The videos are saved on SLU Play (https://play.slu.se) under My Media of the course instructor, and are accessed by students in the course via the Media Gallery of the Course Canvas page (Figures 1, 2).

Our intent was to also generate additional, new active-learning activities to engage the students on each topic in class, but in practice this was limited to a few minor new activities. This was primarily because the creation of the videos took longer than initially estimated. Thus, for the first use of the new videos (during spring 2024), effectively the course was run the same as before, except for switching from in-person to pre-recorded lectures for this course module, and allowing a longer time for students to engage and discuss key concepts during each class period (instead of lecture). This still follows the principle of active learning (students work in small groups to answer questions about the material, then discuss them), but does not involve a shift to new active material. As a result, we can reasonably compare learning outcomes between 2023 and 2024 with the lecture delivery mode being the only substantive change. We intend to further develop additional active learning materials in future years, to complement the videos.

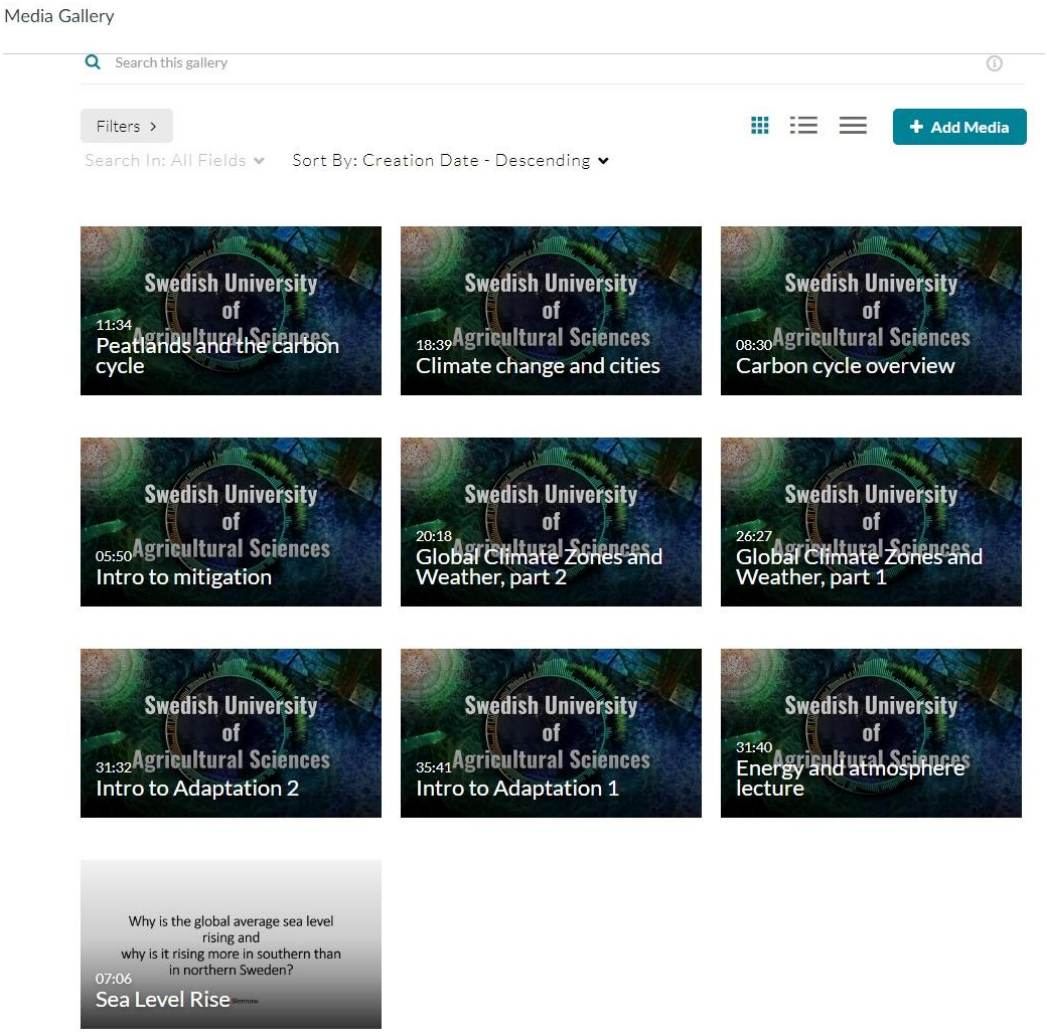

Figure 1. Links to videos found in Media Gallery of the Climate Change courses.

Figure 2. Example screenshot from the "Intro to Adaptation 1" video, with closed captioning activated.

Results - Student Uptake and Reflection

Did the students engage with the material? The students did view the pre-recorded lecture videos, as recorded on SLU Play – with at least 27 independent views of each video (from a possible total of 32 students), and an average completion rate ranging from 86-96% depending on the video. That is, almost all students watched the videos, and the majority watched the entire video.

How did the students experience the pre-recorded videos? Students were encouraged to fill in the course evaluation and given time on the last day of class to do so. We also held an in-person discussion with the students to get feedback at the course end. Of the total 32 students in the two courses, 27 (84%) filled in the official course evaluation in eVald. In general students felt that the lectures in the course were highly useful (Table 1). The use of some pre-recorded lectures (new this year), was appreciated by many as a complement to in-class lectures, and a way to free up more class time for discussion and exercises. However, when asked directly, the students responses ranged widely in terms of their preference for in-person vs. pre-recorded lectures, and this differed between the bachelor's level and master's level students. In the bachelor's course, the majority of students (57%) stated that they strongly preferred the in-person lectures; while in the master's course, about half of the students did not have a preference for type of lecture, about a quarter stated a preference for in-person lectures, and a quarter for pre-recorded lectures. These results are somewhat similar to those found by Brockfeld et al. (2018) who found in a medical prep course that about half of students preferred live lessons, a quarter preferred video lessons, and a quarter were neutral.

Table 1. Overall average response/rating by students, ranging from a score of 1 ("I completely disagree" to a maximum possible score of 5 ("I completely agree").

	Bachelors course (LK0401)	**Masters course (LK0412)**
"In-person lectures by lead instructor were useful"	5.0	4.8
"Pre-recorded lectures by lead instructor were useful"	4.6	4.7
"I prefer pre-recorded video lectures to in-person lectures"	2.1	3.1

Representative comments in the course evaluation about the specific statement "I prefer pre-recorded video lectures to in-person lectures" (together with the rating) included:

"(Pre-recorded videos were) helpful, but I always have a hard time paying attention to pre-recorded video lectures." (3)

"They were great but in their own way. I still prefer in-person lectures." (2)

"I prefer pre-recorded lectures with a personal summary. So I prefer the way it was taught now." (3)

"Both are very useful, but it is still good to have in-person lectures to stay focused and be able to interact with the rest of the group" (2)

"The pre-recorded video lectures are great because we can listen to them whenever you want and even listen to them again, but in-person makes it easier to ask questions." (4)

Evidence for Impact on Student Learning

Did the new approach have an impact on the student learning, and knowledge retention? This is very difficult to judge from a single initial testing of this approach, but we can at least look at the students performance, taken as a whole, during this module of the course. The most straightforward way to do this is to compare the distribution of scores on the exam from this module of the course, which has been, for the past 4 years at least, of a similar scope and format each year. Comparing this year to previous years (Fig. 3), we can make a few rough conclusions.

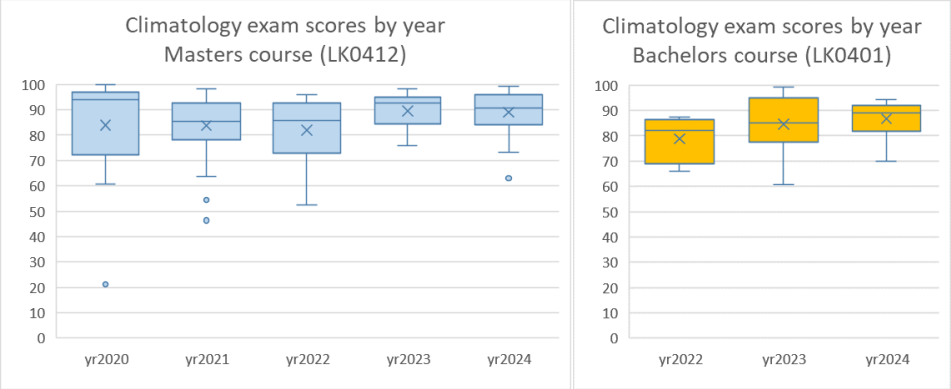

Figure 3. Distribution of exam results for students in the masters course (left panel) and bachelors course (right panel) each year since the lead instructor has been involved in teaching this module. During year 2023 and 2024, the material taught was nearly identical, except that the majority of the lectures were given as pre-recorded videos during 2024, while all lectures were given in-person in class during 2023.

There was no significant difference in exam score distributions between 2023 (in-person lectures) and 2024 (pre-recorded lectures), for either course. In fact, the score distributions are strikingly similar among those two years, especially considering the group of students varies from year and this is expected to lead to some variation in scores. This result suggests that the lecture format had little impact on material retention, at least on the short timescale of our assessment (2.5 weeks of lectures, readings and discussion, followed immediately by in-class exam). This mirrors results found in a controlled study of student performance in a medical prep course, where there was no difference between the test scores of students who received live lectures, vs. those receiving video lectures (Brockfeld et al., 2018).

Interestingly, one thing that we can pick up in comparing the exam scores from year to year, is that the pandemic appears to have had a significant negative effect. In comparing the most recent three years, where we have the most data and when both courses were active, the post-pandemic years (2023 and 2024) had significantly higher student scores than year 2022 ($p=0.028$, Bonferroni post-hoc test following a GLM-Univariate comparison of test scores with Course and Year as Fixed Factors; SPSS v. 29.0). During both 2021 and 2022 this first module of the course was run entirely remotely, using Zoom and Canvas, due to the pandemic. The exam was also administered via Canvas during these two years, though with a similar scope and similar types of questions as the in-class exams. In contrast, 2023 and 2024 were carried out in person on campus Alnarp. The “pandemic effect” could be due to any number of different factors, or a combination: larger class sizes, a shift in the student pool, all lectures being carried out on Zoom, the exams being carried out on Canvas, the lack of personal interaction on campus, or students’ general isolation.

Conclusions and Future Work

Overall, the creation of new pre-recorded videos for the climate change courses was a success, but will require additional iterations and development of complementary material to get the most out of it. The change in approach did not markedly improve (or worsen) the learning outcomes for students in this part of the course. In the first year using the new videos in class, the students were ambivalent about the videos, and many would still prefer in-person lectures, especially in the bachelors course. There is clearly a need to retain some of the in-class lectures, which allow for more back-and-forth with the students.

We encountered challenges and some drawbacks to the pre-recorded video approach. The creation of the videos took a lot longer than anticipated, and practically, we had to satisfy ourselves with less-than-perfect recorded lectures. Some of the videos used lectures which had been previously recorded during live class sections, during the pandemic when we were using Zoom. These enabled a more natural back-and-forth feel to the lecture, but also were not as efficient in terms of delivery of core material in a short amount of time – i.e., some were too long. To create a truly effective pre-recorded lecture video, a different approach needs to be taken than when approaching a live lecture – given that the video does not offer opportunities for real-time interaction with the students, for determining the degree to which students are following the material, for answering questions etc. Finally, many students expressed that they struggle to focus on the material as well, when it is delivered in video form; though others stated ambivalence or even a preference for the videos.

The main benefit to using the pre-recorded videos for us as instructors, was freeing up time – both instructor time (not needing to prepare the lecture for each instance of the course), and in-class time (having more flexible time in class to carry out discussions and exercises). The students also gain a bit more unscheduled time, which is meant to be devoted to watching the videos. In coming years, we plan to emphasize more clearly to the students the tradeoff between lecture time and active discussion/exercise time, so that they appreciate what is gained by taking the flipped classroom approach. We also plan to continue to develop additional active exercises to take advantage of that additional in-class time, emphasizing interaction and higher-order learning. Freeing up time to actively engage the material in class is a very important part of the flipped classroom approach, and is hypothesized to be the main reason why the flipped classroom approach can give improved results for learning (Jensen et al., 2015). Thus, this shift in approach may still bear fruit, but requires a sustained effort to continue to implement active learning exercises throughout the course.

References Cited

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