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Going from classroom lectures to online teaching

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Introduction

The COVID-19 crisis in the spring of 2020 meant that courses had to shift to a 100% online learning model, and this shift had to be implemented on extremely short notice, in some cases from one day to the next. Going from pure classroom-based teaching to pure online teaching required restructuring courses to ensure that the students still achieved the intended learning outcomes; however, it also came with several practical considerations. How do you use technology to ensure students achieve the learning goals? How do you ensure that physically isolated students keep their motivation throughout a course? And what is feasible to implement within such a short timeframe?

In this project I will present the considerations taken for the shift to online learning in the elective M.Sc.-level course "The Interstellar Medium and Formation of Stars" (NFYK13017U[1] and referred to as the ISM/SF course henceforth), and I will present the adopted format of the course. Second, I will evaluate and discuss the course based on the standard student evaluation form and qualitative interviews conducted with four students. Finally, I will present which lessons we have learned that can be used both for blended learning and for purely online learning in the future. This particular course had its first lecture day on April 20th, 2020, i.e., approximately four work weeks after the shutdown, and this was the time-

[1] Course description available at https://kurser.ku.dk/course/nfyk13017u/2019-2020

frame given to restructure the course in a manner where the students still achieved all learning outcomes.

Considerations and adopted course structure

Pre-COVID-19 course structure

The ISM/SF course previously ran as a pure classroom-based course. It consisted of 3x3hr lectures per week, where each lecture would typically consist of approximately 1–1.5hr predominantly monologue, perhaps with an activity, and 1–1.5hr exercises that the students would do in class. We would conclude each lecture with a validation and institutionalization of the exercises, and how they related to the given lecture. Between classes, the students would read background literature and couple that to each lecture. According to student evaluations from previous years, the students generally liked the course and felt that they achieved the intended learning outcomes. The course is taught by two teachers, I and associate professor Jes K. Jørgensen (NBI/KU), and we split the lectures 50/50. We continuously update the course, but because the student evaluations generally are very positive and we ourselves are happy with the way the course runs, these updates are usually minor; that was also the intent for 2020.

The adopted teaching model could not be translated one-to-one to an online setting:

- Streaming lectures could be subject to technical difficulties, e.g., poor internet connection both on the teacher and student end;
- Letting students view recorded video lectures during an online session would be inefficient and again potentially suffer from technical difficulties;
- If the lectures were watched asynchronously, how would the additional time be spent?
- Walking between students and looking over their shoulder to see how they are coming along with the exercises is not possible and talking to a single student in an online classroom setting would be disruptive to others.

The points mentioned above are only examples of why a one-to-one translation would not work.

Course considerations

Two main didactic approaches were used to address these points and come up with a new course structure. The first is the didactic triangle (Figure 1; Gundem and Hopmann, 2002), the second is Biggs' theory of constructive alignment (Biggs, 2003). Furthermore, we needed to ensure that these approaches fit within the technological framework, and that their implementation were feasible in the given timeframe. Finally, we wanted to give a solid framework for the course, thus establishing a clear didactic contract with the students.

Starting with the technological framework and the timeframe, we already had course material and slides developed and polished from previous years and it would not be possible to re-develop the course material from scratch. The lectures serve as the principal curriculum and their content needed to be communicated to students optimally. We quickly decided the optimal way was using recorded PowerPoint lectures which the students could watch between online sessions. This resembles the so-called flipped classroom method, where students spend time on their own, learning between classroom sessions (e.g., Bishop and Verleger, 2013).

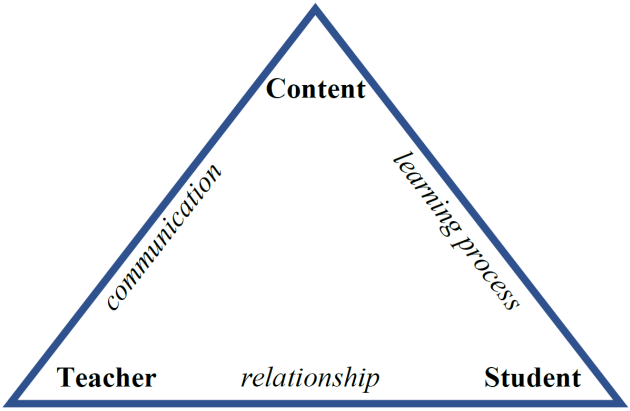

Figure 1. The didactic triangle, highlighting the relationship between teacher, student, and content.

To ensure the best possible outcome of these lectures, we adopted a format where each lecture would last approximately 1hr and be broken into at least 3 segments, each segment not longer than 20min. With a recorded PowerPoint, it is difficult to point and show, so special care needed to be taken to add arrows and other graphic elements to highlight the focus area on a slide. All lectures were uploaded to ERDA[2].

Normally there would be questions during the lectures, we would be able to read the students to see how they were following the lecture, etc., which of course is not possible in asynchronous learning. In order to accommodate this, and to make sure that students would speak together in these times of physical isolation, we decided to spend a large fraction of each online session on group work, where the students would work in specific groups that were formed prior to the start of the course, and which remained throughout the course. A secondary goal of this approach was that it would aid with student self-motivation, which may be difficult to maintain in times of isolation. For these reasons, we encouraged the students to form their own groups, and then we divided any remaining students into groups. The groups ranged in size from 3 people to 5 people. Previously, the students would self-organize into groups, but we deemed this to be important enough to organize it from the beginning.

With these two key elements in place, the recorded lectures and group work, the rest of the course could be used for discussion, both within the groups and in plenum. The course is small enough (app. 20 students) that it is possible to carry out a plenum discussion online without too much trouble. For these plenum discussions to work, we were both conscious about trying to ensure the online atmosphere was still welcoming, which can be difficult because of the lack of non-verbal communication in the pure online setting.

Choosing the online platform in which to execute the course was fairly straightforward: we needed an environment that supports breakout rooms for the group work, it should have a chat function, a raise-hand function, and preferably be a platform we were already familiar with. Zoom fulfilled these needs.

Finally, because of these uncertain times and because of the new medium in which we were teaching, we decided to experiment with small variations during the first two weeks, then held a midway evaluation, and finally settled on a specific format for the remaining part of the course. This was seen

[2] Electronic Research Data Archive; http://www.erda.dk

as advantageous to the students, because there would be a solid framework in place from time to time, and the didactic contract between teacher and student clearly laid out.

Adopted course structure

Based on the above considerations, we adopted a course structure based loosely on the flipped classroom method. We recorded approximately 1hr of lecturing per session, split into videos of 10–20min length each. The students were asked to watch the videos before the online session or lecture, and they were asked to take note of any questions they might have. The recorded lectures were supplemented by background literature, covering up to app. 50 pages per session; the recorded lectures were the primary curriculum and the background literature was intended to provide more details or derivations than were covered in the videos.

During the lecture, we would first send the students into breakout rooms in pre-defined groups. Here they would discuss the main points of the lecture, any remaining questions they might have for the lecture, and then a specific question asked by us regarding the day's lecture, and these would all be written in a common Overleaf document by each group. We would not check on the students during this part.

These discussion points would then be summarized in plenum, where a different person from each group took turns presenting their points, questions, and answer to the specific question every time.

Finally, the students would be sent back into the breakout rooms to do exercises. In the breakout rooms they had the possibility to summon the lecturer to ask for help, and we would also circulate to check on progress at irregular intervals. We attempted to validate and institutionalize the exercise with each group before the students left for the day, otherwise the following lecture would start with these remaining items.

The work done outside the classroom consisted primarily of watching the recorded lectures and any supplementary reading which was deemed necessary by the students.

Course evaluation

In order to assess the students' learning, we held an informal mid-way evaluation after the first two weeks. The following day, we discussed the evaluation with the students both to hear any further elaborations from them, as

well as discussing where we, as teachers, come from and what our thoughts are.

The course concluded with the standard course evaluation, which this year was augmented with specific questions regarding the online format.

Finally, I conducted qualitative interviews with four students individually. These students were selected on the following grounds: they represented as many different study groups as possible, they had been present for more than 80% of the lectures, there was a gender balance, and neither my co-teacher nor I are currently or will in the future be working with them on their MSc projects. Each interview is recorded but not made publicly available for GDPR reasons. In the following, these four students will be referred to as NN1 – NN4. The interview guide is included as supplementary material.

I chose to focus on students who participated regularly in the majority of the course, and thus neglected the few students who did not. The reasons these students did not participate thus remains unknown, and it is conceivable that the online teaching did not work for their learning.

Course structure and elements

The qualitative interviews and the written evaluations, both midway and final, paint the same picture, broadly speaking. The students who filled out the free-text answers in the evaluation highlighted many of the same things, and it is perhaps not surprising that the interviewed students shared these opinions; they may have filled them in in the evaluation to begin with. For this reason, the results presented here will mainly focus on the qualitative interviews.

During the interviews, the four students were first asked to rank the various elements in order of how beneficial they were for their learning, 1 being the most beneficial and 5 the least, and then subsequently go through and discuss pros and cons of each element; these are listed in Table 1. When looking at the average scores, two things emerge from the ranking: the students valued highly the video lectures and exercises (apart from getting the highest average scores, both these elements also received top ranking by

two students), as well as the group discussions. They valued less highly the plenum discussion and the background reading, on average.

Table 1. Ranking of the various lecture elements in order of how beneficial they were to their learning by the four interviewed students, 1 being the most beneficial and 5 the least.

Element	NN1	NN2	NN3	NN4	Avg
Background reading	5	5	5	4	4.75
Video lectures	1	3	3	1	2.00
Group discussion	2	2	2	3	2.25
Plenum discussion	3	4	4	5	4.00
Exercises	4	1	1	2	2.00

When asked to elaborate on these specific elements, the students had the following to say.

Background reading. The consensus was that this was a necessary evil. There is no difference in how we used the background literature in a classroom or an online setting, and although the students recognized the quality of the selected literature, it did not do much to improve their learning of the subject material (nor did it impede their learning).

Video lectures. The interviewed students all took advantage of the recorded format and would pause the videos or rewind to make sure they understood the information. They all agreed that the 10-20min format worked very well, in that longer videos would be unmanageable. Most students agreed that it took approximately 3 hours to watch 1 hour of video lecture, when including note-taking time, pausing, rewinding, etc., and so it made sense for them to watch 1–2 videos and then take a break. Furthermore, the way in which we had set up the lectures, where something new appeared on each slide every 20-30 seconds (a new bullet point of text, a new figure, an arrow highlighting something in a figure) made it easy to keep focus, as opposed to hearing a voice and seeing no visual change for minutes at a time (NN2). In order for this to work, it is clear that the technology needs to be in place, i.e., having access to a good microphone, but also having good presentation technique, i.e., enunciating and speaking extra clearly. The only negative thing was “that it was impossible to interrupt and ask questions during the recorded lecture as in a normal classroom” (NN4). In spite of this, all four students found that the recorded lectures worked so well, that they preferred them to in-classroom lectures, and that this was perhaps the biggest positive change to come out of the switch to online learning.

Group discussion. The group discussions required a certain level of preparation by the students, in that they needed to have watched and understood the lectures beforehand. In the words of one student, "this led to a positive peer pressure because we needed to have the plenum discussion afterward where one of us would be forced to present the summary points" (NN2). Furthermore, the discussions were held in a specific framework which was necessary for the success of these discussions: these weren't a free-for-all. This framework was generally seen as required for the success of the discussions to keep them focused on the topic of the day. Some groups were able to cover any remaining questions about the video lecture within the group and were able to answer each other's questions without the need to involve the teacher. Writing down these summary discussion points in a common online document was also seen as incredibly beneficial by all students, both for their immediate understanding and as a guide when revising for the exam. On the negative side in terms of the students' learning, one feature was that the students could follow the progress of the other groups in the common Overleaf document. This sometimes led to a level of "meta gaming" (NN3): "if everyone else is writing this key point, maybe we should do the same because we don't want to appear stupid".

Plenum discussion. This part of the lecture was generally not seen as particularly efficient or cost-benefit friendly. One student appreciated the chance to hear what the other groups had come up with, particularly in terms of the answer to their specific question which the group had not had time to look at during the group discussion (NN1). In this respect, the students remarked that it might be beneficial to have more time for the group discussions, and then specifically task them with also spending time looking at what the other groups say during their own group discussion time. This could be done by asking each group to first cover their specific question, then go through the main points of the lecture, before going over any unanswered questions they still had. An additional task would then be to look over what the other groups had done for the remaining 5 minutes of the group discussion. In doing so, the students would still be able to understand the main points from the other groups and to the same level, but without spending too much additional time on it in plenum, time which was better spent on other activities.

Exercises. While doing exercises as part of the course wasn't a new element, what was new was to let the students do the exercises in set groups, the same groups as used for the discussions. This ensured that students who wouldn't normally participate actually took part: "you can participate in

the discussion, and pause the discussion if you prefer to work alone for a bit, while still listening in on what the others are saying and not miss out" (NN1). One of the biggest challenges was for the teachers: while we would normally walk around and casually check that nobody is stuck, it was experienced as a disturbance if we joined the different breakout rooms. At times this was fine, the students actually needed help, but the students very much preferred to be left alone as much as possible and call on us for help when needed. One feature in Zoom is that you can ask the host (the teacher) to join a breakout room, which is equivalent to raising your hand asking for help. The students used this feature every time, and it had the advantage that the students couldn't see how busy we as teachers were: "if [in a classroom] you can see that two other groups are signaling for help, and the teacher is already helping a third group, you realize there is no way the teacher will have time to reach your group, and it becomes futile to even consider asking for help. However, if you can't see how many are before you in asking for help, there is no reason not to ask for it when you need it" (NN2). One barrier existed, compared to doing the exercises in person: the help of visual aids, particularly when the students just wanted to write down a quick idea, jolt down some equations, draw a sketch, or the like (NN3, NN4). While some groups used shared Google Docs, Maple, Jupyter notebooks, or simply held up a piece of paper with a sketch or equation, and we ourselves used similar tools, not all groups thought about these tools or found them cumbersome to use.

Summary. In general, the students enjoyed the format of the course and the chosen elements, and they thought they worked well for their learning. When asked if other elements could be included to improve their learning, they all had various specific ideas that spoke to their own preferred methods (examples included doing small projects you choose the angle on yourself and then present to the class, the teacher asks questions to the students during or after the video lectures, handing in written assignments for personalized feedback, discussion forum in Absalon, more "private" time with the teacher for questions/interactions), but there was no general consensus on specific elements that were missing. It is of course difficult to imagine one specific thing that would have improved the course, especially if your general thinking is that the course actually worked well.

Course environment

One specific challenge of online learning compared to the traditional classroom learning, is the missing personal interactions, both between teacher and students and between students themselves. All four students remarked on this lack of interaction, and that it was perhaps the biggest barrier for their learning compared to traditional learning. It is interesting to note that all four students saw this as one of the major barriers in online learning, yet it practically didn't appear in the standard evaluation form.

This barrier manifested itself in different forms. As an example, the ability to speak informally to the teacher in connection with a classroom lecture or by bumping into them randomly in the corridors was gone; "sending an email seems too formal, normally I would just knock on the teacher's door or catch them before or after a lecture" (NN2). This lack of rapport between teacher and student meant that students felt more distanced from the teacher, which did not help in learning (cf. the didactic triangle).

Having a set structure throughout the course ensured a positive alignment between us, as teachers, and the students, and there was a clear contract between us and the students: after the first one or two online lessons, they knew what we expected from them during the sessions and could prepare accordingly.

Lessons learnt going forward

Perhaps the most fundamental lesson to be learned from this experience is that students do not learn in the same manner if the teaching is online as in the classroom. Online teaching comes with opportunities and possibilities not found in classroom teaching, and vice versa. To optimize the students' learning, it is therefore crucial to consider exactly how to take advantage of the medium through which learning takes place.

Based on the MSc-level course, the Interstellar Medium and Formation of Stars taught in Block 4, 2020, at the Niels Bohr Institute, the following key points can be extracted.

- Recorded video lectures work very well for the students' learning, as long as the videos are relatively short (10 min is better than 20–30 min), something happens every 20–30 sec (e.g., a new bullet point of text, an arrow showing something on a figure), and the recording is of high quality. The ability to pause, rewind, and repeat is perceived as

the most important part of online learning and should not necessarily be limited to online learning; we intend to use the recorded lectures going forward in a blended learning/flipped classroom environment.
- Group work is important for keeping a level of social interaction which is otherwise difficult to achieve in a purely online setting. Although there is a preference for forming the groups themselves, this is less important. The ability to interact informally with peers in a structured format provides a more relaxed environment, which eases the ability to learn.
- It is important to give students the time to work for themselves before checking up on them, both individually and in groups, and this is even more important in an online setting: in the classroom, the teacher can stand at a distance and still eavesdrop, which is not possible online.
- Keeping a clear structure to the course strongly helps in negotiating the didactic contract between teacher and students and align their expectations accordingly. Particularly in an online setting where everything is new and no one knows what to expect, this provided a structure which gave the students the time and energy to focus on learning.

All in all, although the corona crisis meant a lot of adaptions had to be made on very short notice, it is clear that with a few small modifications many courses can be adapted to an online format. While some things are better done in person, many online elements can be implemented in the traditional classroom to enhance the learning of students, even if there are no imminent health threats.

References

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A Supplementary material. Interview guide, qualitative interviews

[The course which I taught, The Interstellar Medium and Formation of Stars and Planets, is in the following abbreviated to ISM/SF. Translated from Danish.]

Which online courses have you followed this spring, either completely or partially online, apart from the ISM/SF course?

Think of a traditional classroom course which worked very well, in the sense that you felt you learned a lot:

- Which elements did the course consist of (e.g., monolog, exercises, discussion, group work)?
- Which of these elements worked particularly well for enhancing your learning?
- Did other factors contribute to optimizing your learning (e.g., external factors such as particular interest for the subject)
- Were there pats of the course which could have been improved? Inclusion of other elements, elements that weren't necessary?

When thinking back to the online courses you followed in the spring, what has been the most positive you have experienced in the context of your own learning? And what could use most improvement?

What have you experienced is the biggest difference between classroom and online learning? What worked better online than in the classroom and vice versa?

Specifically, about the ISM/SF course. The course consisted of the following elements:

1. Background reading
2. Recorded lectures
3. Group summary discussion
4. Plenum discussion
5. Exercises

If you had to sort these elements according to what worked best for your learning, how would you do that? What worked particularly well with each element? And what could be improved?

Are there other elements which could be included to improve learning? Possibly inspired by other courses.

How did the online exam work, pros and cons about the online format compared to the traditional exam?

Any final thoughts/remarks you would like to make regarding online learning?