

## **From a traditional to flipped classroom**

### **– a course redesign to foster learning and engagement**

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### **Background and motivation**

The BSc course *Danmarks Fauna* is popular among biology students at the University of Copenhagen, drawing 50–80 students every year. The course introduces students to Denmark's faunal diversity through a mix of auditorium lectures and subsequent hands-on time in a smaller classroom, where specimens from the vertebrate collections from the Natural History Museum of Denmark are studied in detail.

The course has been running for 10 years, and receives positive reviews. However, when auditing the mammal lectures in spring 2016, some of which I will be teaching from 2017, it struck me that the student learning and engagement might be improved by changing the format of the lecture from a (mostly) one-way projection of information, to something more dynamic.

While taking Universitetspedagogikum at KU-SCIENCE in 2016, I was introduced to the concept of blended learning, and met colleagues from other institutes who have successfully flipped their classrooms. Although I have followed several Coursera courses over the past few years, I had not considered that university courses could be flipped, having never experienced this format myself as a student or otherwise. The introduction of the flipped format made me realize that the course *Danmarks Fauna* would be an ideal course to flip.

Here, I will introduce the concept of a flipped classroom, discuss why I believe students and teachers alike may enjoy and benefit from flipping *Danmarks Fauna*, and showcase what we are doing towards flipping the

course, which will hopefully be fully flipped by 2019. It is my hope that other colleagues at the Museum (and elsewhere) will be able to use this paper as a vantage point to consider a flipped format for their own courses.

For this task, I have had many hours of fruitful discussions with my fellow teachers from *Danmarks Fauna*, Kasper Thorup and Peter Rask Møller, who have taught the course since it started. We have also had discussions with Jeppe Sand Christensen and Henrik Kaas from the Science IT Learning Centre, University of Copenhagen. Finally, I have read relevant primary literature, blogs, and educational online material from various universities that are experienced in flipping classrooms.

## **The flipped classroom**

The flipped classroom is a relatively new pedagogical model in which the typical elements of a course – a lecture followed by homework – are reversed (Initiative, 2012). In a flipped setting, students prepare prior to attending class by viewing short online video-lectures produced by the instructor/teacher(s). The face-to-face (F2F) time between instructor and students is spent in an active learning setting, with discussion, projects and hands-on activities, rather than in classic lectures.

## **The benefits of flipping**

There are many benefits to flipping a classroom, for both students and teachers (Table 2.1).

In a classic lecture setting, the instructor prepares material to be delivered in class (Figure 2.1). Students listen to the lectures and take notes, and homework is assigned to demonstrate understanding. There is little – if any – time for reflection during class.

In the flipped classroom, students come prepared. The instructor records and shares lectures online prior to class, and students prepare by watching these before coming. Often, online preparation will include quizzes or assignments, which enable the instructor to ascertain the level of student understanding prior to class, and pinpoint the parts of the curriculum that may need more focus. Class time is devoted to applied learning and higher-order thinking tasks (Figure 2.2), and students receive support from the instructor and fellow students when needed.

Table 2.1: Some advantages of a flipped classroom. Synthesized from Herreid and Schiller, 2013 and Gilboy, Heinerichs, and Pazzaglia, 2015.

Teachers can more easily customize and update the curriculum and provide it to students 24/7
Doing activities in class gives teachers better insight into student difficulties and learning styles
Classroom time can be used more creatively and effectively
Learning theory supports the new approaches and the use of technology is flexible and appropriate for 21 <sup>st</sup> century learning
Students move at their own pace
Students are given ownership and responsibility for their own learning
Students are actively working with their peers
Materials are available online and can be viewed at leisure by those who miss class, and can be viewed as many times as necessary
Students get more time working with scientific equipment that is only available in the classroom
Students are more actively involved in the learning process
Students really like it

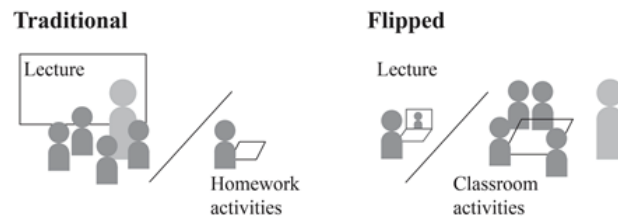


Fig. 2.1: Traditional vs flipped classroom. Graphics from Flipping the Classroom, Center for Teaching and Learning, University of Washington. Available at <http://www.washington.edu/teaching/teaching-resources/engaging-students-in-learning/flipping-the-classroom/>.

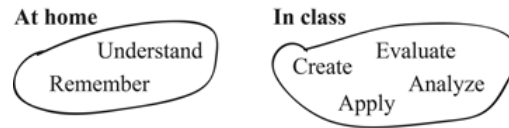


Fig. 2.2: In a flipped classroom, students come prepared to class and engage in active learning. Figure adapted from <http://www.michaelserra.net/>.

In a flipped F2F class, teachers function as facilitators and advisors rather than as one-way projectors of encyclopedic knowledge. They focus on being a ‘guide on the side’ and not a ‘sage on the stage’, and encourage individual inquiry and peer learning. Whereas in the traditional setting, the students are merely passive receivers of information, the flipped approach is student-centered; the focus is shifted from the teacher’s needs to the student’s.

When students come prepared to class, there is little to no need for teachers to address content related questions. That content has already been presented in the online material, which students can view at their own leisure, pausing and rewinding as needed. In the flipped F2F, teachers can support students in better understanding the concepts through practical application. Students apply their new knowledge and build their skills while gaining immediate feedback from their teachers and peers (Figure 2.2).

F2F classes become interactive workshops; students interact directly with the course teacher and other course participants, testing their skills and directly applying their knowledge in case-based problem solving. Through collaborative projects, social interactions among students are encouraged, improving the class atmosphere. In fact, communication and peer learning among students can become the determining dynamic of a session devoted to learning through hands-on work (Danker, 2015). Such an approach allows the teacher to quickly ascertain the level of student understanding; errors in thinking can be detected, and misconceptions can be immediately corrected. Importantly, the flipped format gives students ownership and responsibility for their own learning.

## The challenges of flipping

There are two major issues when flipping a course, which each require time and effort. The lectures need to be transitioned to online material, perhaps videos, and methods of online assessment tool(s) have to be developed. Also, the corresponding F2F classes will need to be restructured and re-designed accordingly, to include activities for active learning.

Limited time, expertise, and resources for conducting such a course redesign often result in either a decision not to redesign the course or, worse yet, courses that are even less effective than the original (Brown, Edwards, Alshiraihi, and Bowser, 2017). Flipping successfully requires dedication and careful preparation. It is, after all, much faster and easier to give a series of lectures, without having to think about student learning and engagement, not to mention the production of the online material.

Pre-recording lectures and making them available online prior to class requires resources in addition to time, both of which may be in short supply. If the ambition is videos rather than lecture podcasts, camera and editing equipment are needed. As is the good will of one or more colleagues who will be required to film the videos. Editing is also an acquired skill, and teachers will need to be involved in the editing process, even if it is outsourced, to ensure the intended learning outcomes are met.

However, once a video is done, it can be reused until the content becomes outdated. In this regard, *Danmarks Fauna* is an ideal course; mammals, birds and fish will always have their distinguishing characteristics, and the faunal diversity of Denmark is unlikely to drastically change anytime soon. However, once produced, the University owns the course material, and it is therefore worth reflecting over what this means for the role of the individual instructor, should s/he leave the course.

Student learning during the online part of the a flipped can be assessed with various methods including quizzes, to ascertain what components of the curriculum students may not have grasped prior to their arriving in class. The development of good assessment tools requires time and careful preparation. Any questions and assignments must be carefully designed so as to adequately inform the instructor of student learning. Getting such tools right is no easy task. However, when the assessments work, insights into student understanding prior to F2F class allows teachers to identify problems, and F2F classes can be focused accordingly.

The bulk of work required to flip a course may be mitigated by a slow transition, which reduces the effort required by each instructor by spread-

ing out the time needed to produce the required online material before the start of the course. By changing only a few components at a time and slowly transferring lectures online, instructors have the freedom to try out different formats and figure out what works best. There is time to reflect, and adjustments can be made. This will save a lot of time and effort in the long run. For courses with collaborative teaching such as *Danmarks Fauna*, a slow transition furthermore enables time for peer discussion, and instructors can learn from each other. Indeed, the development and implementation of a flipped course comprises as much active learning for the instructors as for the students participating in the F2F classes of a flipped course.

Students may initially be resistant to the idea of a flipped classroom, even if they are millennial kids and used to watching youtube videos. They may not have tried the format before, or a flipped classroom may go against their expectations of what university teaching ought to be. To get students used to the idea of a flipped setting, where they have to come prepared and actively participate during F2F class, a course can be transitioned slowly, over several years, and introduce only a small component of online material at a time.

There are ways to ensure students come prepared and do work with the online material prior to class. An option is to design quizzes that students must pass them in order to continue watching the next online video. Alternatively, it could be a requirement that the student pass all online quizzes/assignments to be eligible for the course exam. However, it should be made clear at the start of the course that the online assessments are included so the instructor can assess student learning, and use the F2F time best. The online assessments are not a part of the final grade, and this must be made clear to the students at the get go. Key to the teaching methodology is deep learning; if students think the online material is part of the exam, they may shift their focus from the process and the learning may become superficial.

Our hope is to provide engaging videos and develop classroom activities that focus on student-centered learning and active engagement. But ultimately, we want students to have an incentive to come prepared. Therefore, the F2F lab practicals should be meaningful, and the format should necessitate that students come prepared if they want to get the most out of class. This can be achieved if students experience that it pays off to come prepared. For example, if a critical mass of students does come prepared, social regulation can develop and students that have not prepared will stop showing up for class.

### **The case course: *Danmarks Fauna***

The course *Danmarks Fauna* is a flagship BSc course at the Natural History Museum of Denmark, and draws 50-80 biology students each spring. The objective of the course is to introduce students to Danish faunal vertebrate diversity, and the course currently comprises a mix of traditional lectures and lab practicals.

The course runs over 7 weeks in block 4. Each week comprises three 4-hour sessions. Six instructors teach it collaboratively, and collection staff help running the practicals. A few field excursions are included in the course, such as a day spent fishing and describing the diversity of a local lake, an early-morning birding trip, a late-night field excursion in search of bats, and a walk around Dyrehaven in search of hooved mammals and reptiles, however most of the classes are taught in-house.

At present, each 4-hour session comprises a 45-minute introductory lecture, usually covering an animal group (e.g. carnivores or rodents for the mammals). This is followed by a short break, while students make their way to the lab practical, where students study specimens including skulls, skins and animal in alcohol from the bird, fish, mammal and herpetology collections. Due of space limitations and the limited number of specimens, students are split into two groups that each have 90 minutes for the practicals.

Importantly, the flipping will not reduce the number of student confrontation hours, or the course workload. By changing the way the course is taught, we will redistribute the hours. Lectures will be moved online, freeing up one hour per 4-hour session. This hour will be split among the lab practicals, which will each be extended from 90 minutes two full hours. The half hour less that every student will have in class in total, will be spent on preparing for class using the online material.

*Danmarks Fauna* was developed 10 years ago, to provide a course for biology students that introduce them to the natural history and vertebrate faunal diversity of Denmark. The format of the course has remained unchanged, and the instructors agree that the time is ripe to evaluate and perhaps redesign components of the course – one change already in place is the switch from a 20-minute oral exam to a multiple choice exam, which will run for the first time in 2017.

## The incentive for flipping

I audited the mammal part of the course in spring 2016, as I will be teaching parts of this component from 2017. At the same time as I was auditing the lectures, I was introduced to the concept of a flipped classroom during Universitetspedagogikum. In addition to believing that flipping *Danmarks Fauna* could benefit the course, students and teachers alike, my incentive for proposing a flip is driven by a desire to broaden my own teaching platform to accommodate a wider range of learning styles (Figure 2.3).

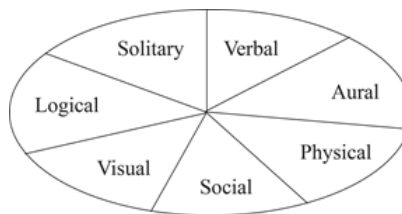


Fig. 2.3: Spectrum of learning styles. Like a fingerprint, each student handles new information according to their own unique response to factors within the learning spectrum so that no two students learn exactly alike. Adapted from Brown, Edwards, Alshiraihi, and Bowser, 2017.

Furthermore, I believe flipping will:

1. *Engage students and foster learning.* In their current format, the 45-minute lectures introducing each session do not work well. The one-way projection of information by the instructor does not engage students or foster learning as well as other methods might. Our lectures directly precede the lab practicals, and students therefore have little time to reflect on what they have just heard, or indeed to realize whether there is anything they did not fully grasp. The lectures have become a necessary evil for introducing each animal group prior to the practical, a way of getting everyone together in the same room and on the same page. Parts of this material could easily be transferred to online videos/quizzes to be worked with prior to class, and the rest could be facilitated and worked with during the F2F practicals. As the primary lectures introduce the biology, ecology and diversity of Danish fauna, and this information is unlikely to become outdated soon, parts of the curriculum is well suited to being presented via online video lectures.



2. *Free up more time for F2F lab practicals.* We are already tight on time during the lab practicals, especially for those sessions covering an animal group with a large number of species, where each species needs to be identified. By moving the intro lectures online, a full hour will be freed up per 4-hour session. This time hour can be split among the two lab practicals, which will each gain 30 minutes, increasing the current 90 minutes F2F time to 120 minutes. The excess 30 minutes that each student saves by not having lectures can be spent on online preparation prior to class (Fig. 2.1). Hence the total workload of the course should remain the same after flipping, with an increase in the time spent on preparation and F2F, at the cost of the lectures (Fig. 2.2). The lab practicals are the defining part of the course, and students benefit immensely from studying the museum specimens directly, and really enjoy it – short of spotting the critters in the field, this is certainly the next best thing.

3. *Improve the delivery and format of information.* The lectures are very heavy on knowledge that the students must learn off-by-heart; the main objective of the course is species identification. By splitting 45-minute lectures into short 5-8 minute videos with one or a few learning objectives each, students can easily switch between videos and pursuing information by other means, fx by reading their text book, or using online resources. Furthermore, instructors can utilize the 33% increase in F2F time during lab practicals on additional activities that foster student engagement and learning.

## **The process of flipping**

The other instructors involved in the course agree that flipping *Danmarks Fauna* is a good idea – none of us are enthused by the classic lecture setting - and we are therefore in the process of redesigning the course (Fig. 4).

F	Figure out which topics you want to flip
L	Locate content-based resources to make available to students outside class
I	Include an incentive for students to complete the work such as a quiz or writing assignment
P	Provide in-class activities for students to apply to the content they learned outside of class

Fig. 2.4: Four easy steps to flipping the classroom. Adapted from the University of Tennessee Chattanooga Think Achieve website, available at <http://www.utc.edu/think-achieve/flipped-classroom.php>.

In the following, I will use the redesign of my own teaching component of *Danmarks Fauna* (mammals) to describe how the transition can be facilitated, and discuss the resources that are available for the implementation of a blended learning course at KU-SCIENCE.

We plan to make a slow transition, fully flipping our lectures by 2019. For this year, we will produce only a handful of short online videos, and each of the course instructors will produce a video. There are several reasons for this, and we will: (i) try out if the format even works for us and the course, (ii) get a realistic idea of the level of resources, time and effort needed to fully flip our course, (iii) test various ways of producing the online material to see what works best, (iv) conduct student assessments over the next two years to assess their response to a flipped format – we are doing this to foster student learning and engagement, and it is therefore important that this goal is reached.

Students will be introduced to the format during the course introduction on the first day of class. As it will be only a handful of videos in 2017, these will be presented by email on Canvas prior to class. Also during 2017, we will plan in detail which component of the lectures are flipped in 2018 and 2019, so students are well-informed of what is to come, and accept the didactical contract that lectures will gradually be reduced, and that online material will be available and is to be worked through prior to class. We will avoid flipping some lectures entirely and others not – there obviously must be a level of consistency among sessions. We are very aware that this is a potential problem. We are six instructors, and the transition to a flipped classroom must therefore be carefully coordinated among all, so the course runs in the same manner throughout. Finding the time for us all

to get together to plan the course and coordinate the redesign of our various sessions is a major hurdle – we all need to agree and align our expectations on what is to happen.

In addition to figuring out how best to make the online videos, we will spend 2017 and 2018 trying out various forms of online assessment tools - what works well, what works less well. By taking it in small steps, we will be actively learning by doing, and will have time to evaluate and tweak the process as we go. An important part of the course development will be peer learning; we will likely be filming each other's videos. Finally, by spreading the workload of flipping a course out over several semesters, we will not have to allot an unmanageable amount of time and effort in any year.

### **So what are we doing?**

We have reached out to the Science-IT Learning Centre (<http://itlc.science.ku.dk/>), which is housed at the Frederiksberg campus. We invited consultants Jeppe Sand Christensen and Henrik Kaas for a meeting at the Natural History Museum of Denmark to discuss how to go about flipping our classroom, what resources are available, and what insights and experience they could share with us. They are now providing us with training and resources to develop and implement this teaching platform.

The fact that we are six instructors on the course has made the up-start more challenging, as we need to agree on how to do this. Although we all have different teaching styles, which we feel is a strength of the course, there needs to be a consensus of and similar style in our online material. And this is the process, which will take the most time. We had originally envisioned that each instructor would produce a small number of short online videos of 5-10 minutes duration for 2017. However, due to the logistical challenges involved in getting all six course instructors together in the same room at the same time to align expectations, discuss video content and agree on presentation form, we have realized that it is realistic to only produce one film each this first year. Hence, the auditorium lectures will still very much be a part of the course in 2017, and perhaps also 2018.

However, to engage students during the lectures, we all came to a workshop 'Asking good questions, and how to do it in a lecture setting with ~ 60 students', run by Jeppe and Henrik. We were trained in making live quizzes, using the program Socrative (<https://www.socrative.com/>), which none

of us had tried before. We agreed that we will all spice up their lectures with a couple of think-pair-share questions or similar, to increase student engagement. We have also produced the first two videos ('Advanced bony fishes' by Peter Rask and 'Swing feathers' by Kasper Thorup). Based on the footage, we are currently discussing the best video format, and plan to film the other four videos prior to course start in six weeks.

The Science-IT Learning Center has several cameras on loan, and free-ware editing software is available for most operating systems. We will be learning by doing, but it will be with the support and supervision of experienced people doing. Our videos will be filmed on location in our respective collections. Not only will this set the scene of the curriculum, it will also allow us to present specimens, pointing directly at what is of interest rather than showing pictures on powerpoint slides, as we have done during lectures.

As we design the F2F component of our classes, we will choose only a few active learning strategies to use throughout the course, rather than a different one for each class. This will allow students to become familiar with the active learning strategy and avoid the risk of students focusing on the process of the strategy rather than the learning related to content. This will require collaboration and communication across the instructors involved in teaching the course.

When we run this year's course, we will keep the design principles of flipping a classroom in mind (Figure 5). Although the course has been running for a decade, it is important that there are clear links and intentions with the in-class and out-class activities, so this needs to be a focal point.

**Student-centered learning**

Teaching presence	Provide incentive for students to prepare for class Provide mechanism to assess student understanding Provide prompt/adaptive feedback on individual or group works
Learner presence	Provide enough time for students to carry out the assignments
Social presence	Provide facilitation for building a learning community Provide technologies familiar and easy to access
Cognitive presence	Provide opportunity for students to gain first exposure prior to class Provide clear connection between in-class and out-of-class activities Provide clearly defined and well-structured guidance

Fig. 2.5: Nine design principles of the flipped classroom. Adapted from Kim, Kim, Khera, and Getman, 2014.

### Assessing the impact of flipping *Danmarks Fauna*

Enhanced student engagement and learning has been reported across the STEM fields, with the majority of students preferring the flipped method compared with traditional pedagogical strategies (Gilboy, Heinerichs, and Pazzaglia, 2015). However, recent research has found that higher learning gains from a flipped classroom may actually be due to the use of an active-learning style of instruction rather than the order in which instruction is provided (Jensen, Kummer, and Godoy, 2015). Our key motivation for flipping the course is to improve the time available to the course: move the lecture material to a more appropriate format online, thereby increasing the time available for F2F lab practicals (Figure 2.1). Importantly, the time spent in class will be the same in the flipped format; we are not moving lectures online to decrease our time in class with the students. Ultimately, we want to develop teaching that engages students regardless of their preferred learning style (Figure 2.3), and fosters their learning to the best of our abilities.

We plan to assess the development of the course, focusing on enhanced student learning and engagement, using in-depth interviews with a handful of students. As we learned during our first UP2016 assignment, one-on-one interviews with students are an insightful way to assess a course and enable a high level of detail, which is impossible to obtain through e.g. questionnaires handed out to all students at the end of a course. This will help us

evaluate student learning as we gradually flip the course, and the student feedback will allow us to redesign the course in the best way possible, for our mutual benefit. We will synthesize these interviews in a paper assessing the impact of the flipped classroom, and hope this will be a useful resource for colleagues who are contemplating a similar course redesign.

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