

## **Improving congruence: setting the stage for meaningful interactions with experts**

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### **Background**

Congruence between didactic elements in a course can foster deep learning in higher education (Mørcke & Rump, 2015). These didactic elements include aspects of learning support, student backgrounds and goals, and the framework of course management (Hounsell et al., 2005). The concept of constructive alignment is further woven into the fabric of congruence and includes didactic elements of teaching and learning activities (TLAs), aims stated in the curriculum, and approaches for assessment and feedback (Hounsell et al., 2005). One of the main duties of a teacher is to keep these ships pointed in the same direction, and to continuously communicate to students throughout the course about how each element is progressing or being sustained.

A central goal in my own teaching is to create a supportive classroom atmosphere where students gain the confidence and competence to engage with complex ideas. This student-centered approach emphasizes communication, learning processes, and teacher-student relationships. These elements also comprise the connections of the didactic triangle upon which increasingly sophisticated pedagogical elements and course content can be layered (Mørcke & Rump, 2015). A focus on congruence and constructive alignment can help balance the didactic triangle and ensure that the pedagogical focus is divided optimally between the teacher, the students, and the course content.

In the study described below, I discuss an initiative I designed and implemented in a Masters-level course to improve congruence between the

course description, the syllabus, and assessment. The goal was to capitalize on real-world expertise of guest lecturers to facilitate authentic interactions between these experts and students to help them understand connections between theory and practice and motivate the students to invest in deep learning.

## The case study

I have been course-responsible for a 7.5 ECTS MSc-level course with up to 25 students called Invasion Biology that has occurred during Block 4 in the years 2019, 2020, and 2021. The field of Invasion Biology is uniquely situated at the interface of theory in ecology and evolution and a broad range of applied issues. In the 2019 and 2020 iterations of the course, I was dissatisfied with the ability of students to bridge these two conceptual hemispheres in their final essays and in their oral exams. Students can usually discuss the details of the spread and impacts of specific invasive species, but they tend to provide rather ‘superficial’ answers to questions about the underlying ecological and evolutionary theory that do not convey deep learning. The course also has a large number of visiting lecturers during the block from the ranks of academia, civil servants in the Miljøstyrelsen, and the private sector. I previously felt that this wealth of professional expertise was not adequately integrated into the summative course assessment.

I inherited this course in 2019 and have not yet made official changes to the official course description, which is divided into the following sections: Content, Learning outcomes (knowledge, skills, competences), Teaching and learning methods, Workload, Feedback form, and Types of assessment. In the course description, a general statement of the main Intended Learning Outcome (ILO) is provided:

*“To provide the students with in-depth knowledge of the population ecology and evolution of exotic and invasive species of animals and plants, including theoretical aspects. To provide insight into methods for studying the mechanisms responsible for the ecological success of these species. To give the students competence in discussing and assessing strategies to counteract possible detrimental effects of exotic species on existing ecosystems and human societies. To train practical skills in oral and written dissemination of the knowledge acquired.”*

The final sentence about ‘practical skills in oral and written dissemination of the knowledge acquired’ also led me to think more carefully about

the idea of competence-oriented education set forth by the University of Copenhagen's educational paradigm, and more generally by Danish universities since entering into the 'Bologna Process' in 1999 (Christiansen et al., 2015). Specifically, I've come to more clearly understand that I could deepen the learning experience by trying to maximize congruence between pedagogical elements and the students' backgrounds, knowledge, and aspirations (Hounsell et al., 2005).

To do this, I devised a project that aimed to help students understand: 1) how research is done in practice (including in their upcoming MSc projects), 2) that the skills gained during the course can be applied to a broad range of fields beyond academic research, and 3) there are many ways to be an amazing and productive scientist. I expected that I could inspire students to achieve deep learning by highlighting authentic real-world applications of their knowledge. I further sought to maintain high learning motivations by clearly linking specific intended ILOs with these overarching course objectives (*i.e.* fulfilling the 'expectancy' criterion, Bomia et al., 1997).

Below, I describe the specific didactic elements I developed to meet these goals and maximize pedagogical congruence.

## Case Study Discussions

In March of 2020, I had just finalized my Invasion Biology syllabus. Then came news of the impending lockdown and the need to shift to online-only education. Like many other teachers, I was forced to quickly reconfigure the course while also retaining the connections of the didactic triangle. One of my key aims was to maximize in-class activation and minimize passive lectures. For instance, I asked guest speakers to deliver pre-recorded lectures that I put on Absalon so that students could watch and re-watch them at their leisure. These speakers came from across the Universities of Copenhagen and Aarhus, the Ministry of Environment, and private companies. Each speaker presented a different 'case study' showing the real-world challenges posed by a specific invasive species and how theoretical concepts from class lectures and seminar discussions about published papers could help mitigate these challenges.

I realized that these brief (ca. 20 minute) pre-recorded case-study lectures were an important resource for the course and I wanted to better align them with other TLAs in the syllabus and with course assessment. I also

wanted to involve the guest speakers in the current iteration of the course without asking them to invest too much time preparing. I thus devised a new ‘case study discussion’ TLA that I hoped would improve congruence while also setting the stage for meaningful and authentic conversations between the students and professional experts in the field of invasion biology.

Additionally, the general goal of ‘preparing students to perform MSc-thesis level research’ is not explicitly listed in the course description. Yet—I felt that such an emphasis could help achieve greater student ‘buy in’ to the other deep-learning goals of the course—especially within constraints of the Zoom format. It seems as though this basic research competence is more important to the students’ future success than specific details about Invasion Biology. I plan to make this goal more explicit when I revise the course description in the future. Below, I describe the specific pedagogical elements that I used to implement this project.

### **Pre-class assignments about pre-recorded case studies**

I assigned seven pre-recorded case study lectures at standard intervals throughout the block. I reorganized Absalon to highlight that these case studies had an equal weight relative to other course elements (e.g. course lecturers, and seminar discussions about invasion biology manuscripts). I made each video PowerPoint visible to the students on Absalon a week before the scheduled discussion with the guest lecturer. I also opened up an assignment for each case study lecture whereby the students submitted three questions about the scientific content in the presentation. These assignments automatically closed two days before the respective case study discussion. This deadline gave me time to read through the questions and curate a list of questions to pose to guest lecturers during each case study discussion. While I initially asked my own questions in a free-flowing way during case study discussions, I revised this approach in response to a student email suggesting that I more formally pose student questions. The student wrote:

*... Thank you for some interesting Invasion classes these last few weeks. In relation to these case studies, I have an idea for future discussions. In the future could you maybe pick 3 or 5 of the ‘best’ questions that students submitted for a walkthrough with the case expert? ... this would hopefully make the discussion most relevant to what we are currently looking at, as well as being an encouragement to write some good questions to begin with. Have a nice day! xxxxxx*

While I decided not to explicitly link individual questions to specific students, I would preface questions by saying “several students asked about X”. I further took the step of organizing the questions into the following topic headings: 1) practical aspects of the research, 2) details about the focal invasive species and its impacts, and 3) the specific research approaches used to understand these impacts. I told students that submission of these questions would not directly count towards the final grade—but I encouraged them to participate—given the usefulness of the discussions for the reasons I described above. Participation remained high throughout the block, across the seven case study discussions.

### **Communicating unconventional approach with guest lecturers**

I felt that it was important to reassure the guest lecturers that the discussion exercise was a bit unconventional, given that I was asking them to emphasize some of the ‘softer’ aspects of science. I drafted a standard email detailing that I would moderate the discussion to keep the dialogue flowing. I emphasized that their pre-recorded presentation from 2020 would be used to bring students up to speed on the scientific details of their research. I noted that we would spend the first 15 minutes talking about the softer scientific aspects. I prepared the lecturers that it may be difficult to elicit much activation over Zoom, that I would curate a list of student-provided questions to keep ask the lecturers. In other words, I would act as a student surrogate.

### **Encouraging meaningful dialogue with experts in the field**

After we finished discussing scientific aspects of the case study, I helped discussions transition to ‘softer’ aspects of the process of actually doing science or working with invasive species. I previously instructed lecturers that while they did not have to prepare anything concrete for the discussion event, they should think through the following three questions:

- **First**, *what are the important practical aspects of doing your research that are not covered in any textbook? (e.g. How do you actually do research? How do you spend your time?)*
- **Two**, *what are some specific issues about your study organism where you are most excited to see research increase or that challenge current assumptions in the field of invasive species biology?*

- **Three**, can you elaborate more generally on some of the most difficult and most exciting parts of your job (or doing research more generally)?

As discussions proceeded, I could sense a shift in the tone of the conversation when we transitioned to these questions. Each of the case study discussions organically took on its own focus and depth. One discussion with a professor nearing retirement focused on long-term changes in how science is done and perceived by the public. Other discussions focused on the pros and cons of practicing science as a civil servant at the ministry of environment (compared to doing academic research), the stresses of getting funding and dealing with stakeholders, the value of international networks, the challenges and opportunities of interdisciplinary collaboration, the value of fieldwork and working in different scientific/societal cultures, the practical aspects of publishing results of a Masters thesis, and alternative career paths in which skills from a MSc in biology can be applied. I received several positive feedback emails from students during the block. For example, one student wrote:

*“Dear Jonathan, I am currently following the course Invasion Biology and I just wanted to let you know that I think it is really, really nice how you encourage guest lecturers to talk about practicals like the ‘real life’ as a biologist, work, studies, and so forth. That is a subject that I personally think a lot of the other courses (and KU in general) lack, so that is very nice. Thank you! Best regards, xxxxx.*

I received similar feedback from guest lecturers. I was encouraged that despite their varied personalities, approaches to science, and cultural backgrounds, all guests approached the experience earnestly and were happy to share their personal experiences as a scientist. Time generally just flew by. While active participation by students varied, many kept their Zoom cameras on and I could tell they were engaged in the discussion.

### **Reflecting on successes and failures with pedagogical advisors**

One case study discussion was observed by my departmental and external pedagogical supervisors. We focused on active student participation (or lack thereof). While student questions were front and center in the discussions, most of the students ended up being rather passive observers during the event. We discussed several benefits of the question submission assignment, including that it: 1) enabled students to sit and ponder the lectures, 2) reduced the stress of having to ask questions live at the event, and 3)

enabled me to control the quality and moderate the flow and focus of the exchange between students and the expert. The main drawback was that this yielded a more passive dialogue between students and the guest expert. We also discussed whether I should enforce that the students turned on their cameras during the discussion, given that it may be perceived as impolite by the guest lecturer.

I have also noticed class-size thresholds beyond which student participation in plenum discussions over Zoom becomes concentrated in a few students. Some participation issues may thus have stemmed from the 'large' class size (capacity enrollment of 25 students). I considered using breakout rooms to encourage smaller group activation, but I ended up deciding against this as I thought it would interrupt the flow of the discussions and not make the best use of the time dedicated by guest lecturers. Instead, I used 'course management' to enhance congruence here by pairing each 45 minute case study discussion with other TLAs that maximized student activation (e.g. seminar discussions). Additionally, the pre-discussion assignment provided a 'flipped classroom' element where student activation occurred independently outside of class.

My pedagogical supervisors also brought up issues of constructive alignment between case study discussions and other TLAs occurring directly before and after the discussions. For instance, a given case study discussion on the invasion trajectory of the Japanese Rose in Denmark was not immediately related to a lecture on 'zoonotic disease transmission' that occurred immediately before, or a seminar discussion on a paper about an experimental approach to testing the Biotic resistance hypothesis that occurred immediately after. I was less concerned with this, as it would have been nearly impossible to achieve this alignment while walking the tightrope of avoiding scheduling conflicts with guest lecturers.

We also discussed whether I should more explicitly link questions to the specific students who posed the questions. I felt that I already had enough 'buy in' from students submitting questions, and that rewards from adding this extra element would not reflect the large amount of work this would require on my part. Another suggestion was that I could structure the discussions more like seminars, where a focal group of 4-5 students was selected for each case study discussion to be in charge of curating a list of questions and guiding the conversation. This was seen as risky from my end, given that the exercise was already unconventional, and a clean line had to be drawn between overly personal questions.

## Improving congruence through assessment

I used three main forms of assessment of the case study discussion TLA. I first provided implicit formative assessment regarding whether or not I selected student questions to pose to the visiting lecturer during the case study discussions. The other two forms of assessment were summative. I describe these briefly below.

### Essay assignment

Half of the grade in the course was determined by a final essay that was composed in the final three weeks of the course using fairly specific formatting guidelines (e.g. page limit, citation structure, text size and spacing, etc.). The main goal was to bridge theoretical aspects of invasive species biology and applied aspects related to case studies of specific invaders. The essay was also framed as a 'grant pre-proposal' designed to provide authentic practice of developing hypotheses and visualizing data that would be central to their own Masters thesis research projects. Students were given the following mandate: "*You are a scientist who wants to acquire funding to study the mechanisms of invasive success of a particular invasive species*".

Students were instructed to write essays with two sections. The first was a brief case study outlining why a specific invasive species is a problem and what is known about the species' distribution, impact, and management. For inspiration, I referred students to the pre-recorded case study lectures and the IUCN website database on the 'world's 100 worst invasive species' ([http://www.iucngisd.org/gisd/100\\_worst.php](http://www.iucngisd.org/gisd/100_worst.php)). Students could not select a focal species that was in this database. I also provided students with a list of theoretical topics that should be addressed in the case study (e.g. transport vectors, ecological and evolutionary mechanisms of invasive success, etc.), and recommended students review the textbook and course lectures available on Absalon. I additionally, guided students to the homepage of the scientific journal "Biological Invasions" where they could get inspiration on choosing focal invasive species.

The second part of the essay was to develop a hypothesis explaining the invasive success of their focal species, including a schematic figure. I helped students review a suite of hypotheses we discussed in the course and gave them some tips about thinking through temporal and spatial scale when developing their hypotheses. The final element of the essay was to devise an experiment to test their hypothesis. I told students they could



generate the figure in Excel, R, or other program using ‘dummy’ data to illustrate the expected result(s) if their experiment supported their hypothesis. Throughout the block, I had emphasized the importance of efficiently and deeply understanding what scientists communicate in figures, and how figures can be used to understand the logic of hypotheses. I was thus pleased that I could improve constructive alignment by integrating this course objective into the essay assignment. Before communicating this assessment plan with the students, I reviewed it with another course instructor from my section that was well-versed in invasion biology.

### **Formative and summative assessment on essay assignment**

I provided students with formative feedback on three occasions as they developed their essays. One week after receiving the assignment, I held a Zoom workshop where students gave brief (3 slides) PowerPoint presentations with their ‘title, idea/hypothesis, and figure’. While not graded, I told students that they would benefit from being prepared—as this would allow me (and another professor/guest observer) to provide them with more detailed feedback. After 2 weeks, I held two well-attended essay workshops where students could ask additional questions on Zoom. I and a guest professor met with individuals and groups in Breakout rooms with the stated goals of: 1) getting help with data/figures, 2) meeting with me and group members, 3) getting input from fellow students, and 4) opportunities to ask questions about general concepts from the course.

Summative assessment occurred during the final oral exam. Students prepared 6 minute PowerPoint presentations of their essay. These presentations were followed by a 6 minute discussion between the student, myself and an internal censor. Feedback was provided at the end of the students’ oral exam in the form of a final grade and our reflection on the details of their written essay and the oral PowerPoint presentation.

### **Conclusions**

I was generally pleased with the ways that a focus on congruence improved the quality of the essays and the integration of theory and practice demonstrated during the oral exams. When compared to previous years, students showed an enhanced ability to discuss specific hypotheses and to support their conclusions with specific case study examples. Student comments

were generally positive although, not surprisingly, this approach was not for everybody. And, while I believe that students are leaving this course better prepared for formalize their Masters thesis projects and place the scientific skills they gain in the bigger picture of ultimate career goals, other students would prefer that I stick to more theoretical aspects of Invasion Biology. I look forward to improving the case study discussion approach for next year's course.

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