

Educating large number of students while developing an academic career

Learnings from the bachelor course on project management

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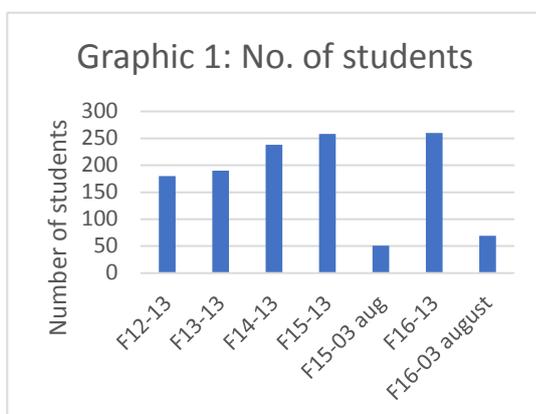
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Introduction: Need for education for large class

Engineers and engineering students recognise the criticality of project management to their profession. According to Dimittendundersøgelsen (Damvad, 2016), former DTU students express a need for more education in project management¹. From the 1,361 students surveyed, 89% rated project management competences as important, but only 54% report gaining such competences while they studied at DTU. This result is consistent across nearly all study lines. The survey confirms the importance of project management to engineers. Indeed, the specialized engineering competence is the most important competence of engineers, but project management is the second most important competence of an engineer, because it enables the engineer to connect with others and develop more complex and relevant solutions.

Furthermore, projects are vehicles to implement change, and hence indispensable to “to develop and create value using the natural sciences and technical sciences to *benefit society*” – the mission of DTU. Thus, project education is not only relevant to professional future of students but also connects and enables the achievement of DTU’s mission.



The consequence is that we educate an ever-larger number of students on project management. The number of students taking our course reached to over 250 students in the classroom since 2015 (See Graphic 1). Similar trend can be observed across different courses at DTU, as the number of students enrolling at DTU every year increases, while, at least some departments are reducing the number of courses available for students to choose from. This trend is observed across continents, in both developed (e.g. Mulryan-Kyne, 2010; Page, 2006) and developing countries (e.g. O’Sullivan, 2006).

¹ This was also the case in the previous investigation from 2012.

Teaching large classes is not a new phenomenon. In countries like Germany and France, teaching 600 to 1,000 students was and continues to be common across universities (Gibbs & Jenkins, 1997). Actually, large classrooms with one-to-many 'transfer' of content is the common 'image' of a lecture. Just as an illustration, Figure 1 provides the results of a google images search for 'lecture'.



Figure 1: Result of a google image search for the term 'lecturing'²

What is new is our understanding that 'lecturing' is not an effective approach for 'learning'. Learning requires stronger activation of students, enthusiasm, and better interaction between lecturers and students. Educational debate seems to accept that large classes have a negative impact in teaching and learning. For example, Blatchford et al (2011) tested the impact of class size in education of 686 pupils across 49 schools. As expected, smaller classes allowed teachers to give pupils more individual attention and have more active interaction with them. Such practices were particularly beneficial to lower attaining pupils. A number of publications show similar research results (e.g. Blatchford, 2003; Cooper & Robinson, 2000; Mulryan-Kyne, 2010; O'Sullivan, 2006).

With growing pressures for increased efficiencies in higher education, the situation is unlikely to change. Without embarking in a political argument about resources in higher education, and education in general, we will accept the situation and address to its consequences:

How to educate a large number of students effectively, i.e. with the desired effect on student learning?

One alternative is a focus on traditional learning methods, multiple-choice exams, and a deterministic learning path. However, such tactic is unlikely to develop the reflective practitioner required for project management practice, and reflective citizens, which is what we conceive to be one of the key roles of universities and scholars, as argued in e.g. Boyer (1990).

This article describes and analyses our experience – successes and failures – of our ongoing program to change education of project management to engineers at DTU with the mission to educate 250+ students on how to DO projects, as opposed to teaching normative tools and techniques. We therefore not only wish

² Source: Result of a google image search, https://www.google.dk/search?q=lecturing&client=firefox-b&source=lnms&tbn=isch&sa=X&ved=0ahUKewily8anIjvQAhXIXSwKHT1yB5UQ_AUICCgB&biw=1580&bih=685#tbn=isch&q=lecture, consulted on 7.11.2016

to educate large groups, but also encourage them to actively engage with the topic, and develop an analytical and pragmatic approach towards current project management practices.

Such aspiration is only possible if we develop research-based education. The consequence is that on the top of the demands to educate over 250 students, we should (and would like to) maintain and develop our roles as researchers in projects. Therefore, we argue that developing our academic research career is required for education.

After a brief description of our approach to this challenge, we analyse the key challenges moving from educating small to educating large number of students. We then provide an overview of our course, and discuss how the different elements of the course address (or at least attempt to address) the challenges of educating large number of students. The final part of the article discusses our current results, and propose avenues for future practice and research on teaching large number of students.

‘Methodological’ Approach

We applied action research as a methodology for the development of our course and reflections and the practices we will analyse here.

We then took a step back from the development of the course itself (during the Autumn term), and reflected about the implications of having large classrooms. Our reflections was based on the comparison between our experiences in very small classrooms, with 25 to 30 students, and what would change as the number of students grow to 250+. The numbers are arbitrary and just used to guide our thought process. In particular, we anchor the thought process in this very course, which has two versions, an August intensive 3-week course with less than 100 students, and the Spring 13-week version with over 250. After several interactions, the ‘case comparison’ led to four key challenges related to the teaching of large classes and the need for a fruitful ecosystem supporting the courses.

We then moved to our practices in the course. We listed all innovations we implemented in the last years, as well as other working practices that helped addressing the challenges of large classrooms. Subsequently, we analysed the practices systematically with regards to our rational for the implementation of the practice, with particular focus on the education of large groups, and compared it with the actual benefits and ‘disbenefits’ it created, and our lessons learned. This approach has been inspired by benefit management methodology (one of the approaches we cover in our classes).

The methodology has obvious limitations as it is anchored in only two case comparison and our experiences, and related biases. However, the resulting framework can act as a starting point in the reflection and theorising about the challenges and practical implications of educating large classrooms.

Challenges

The reflection on the move from small to large student classes led to four challenges and a need for a fruitful ecosystem, displayed in Figure 2 and described in the next paragraphs.

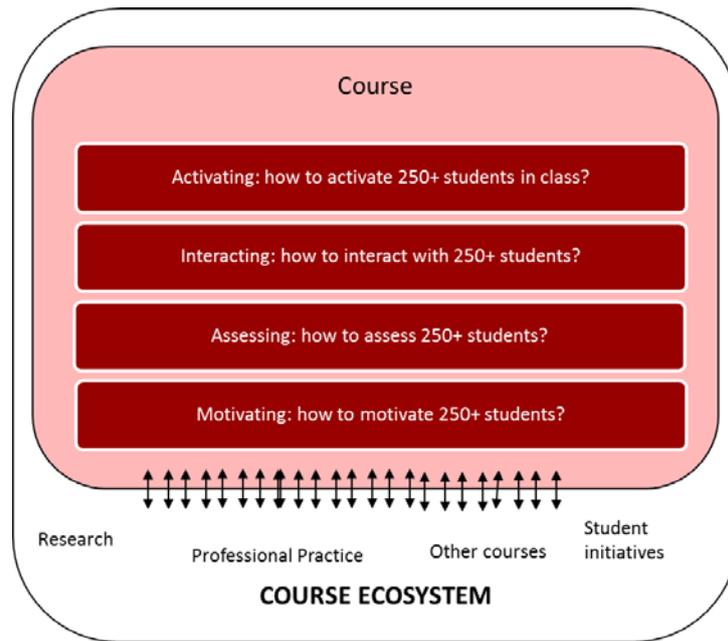


Figure 2: Overview of the challenges

Activating: Biggs (1999) seminal research showed that students learn when they *actively* engage with the content of the class, as opposed to being lectured at (regardless of how good the lecturer really was). The research questions the effectiveness of the widely used ‘church style’ teaching, where one lecture gives, at best, a little show on the subject of the day.

Activating students in a large group can be challenging. Activating a few students into a topic is relatively simple, as it is easier to ‘know your audience’ and connect to what students are interested in, or have experienced, or knowledge shared across the cohort. Moreover, small group discussions, conversations and debates are less time consuming and intimidating and can be powerful tools for activation. However, in large groups, there is often little common denominator across all students in the room. If the subject or example interests 25% of the class, the other 75% are bored and already deviated attention elsewhere. Group exercises where students will actively engage with subject is obviously also possible with large groups, however, lecturers have difficulties to overseeing and interacting with all the different groups, guiding the exercise and encouraging the required reflection. Often also the classroom itself doesn’t enable group discussion. This leads to the challenge: How to activate 250+ students in class?

Interacting: Interaction between lecturer and students is known to be a key contributor to learning. Another evident problem of educating large number of students is that lack of individual attention and closer interaction with students at individual or small group level. A two-way communication in class is diminished and we have difficulties to understand what are the strengths and weaknesses of students, so we can help them develop even further. Moreover, changes to course design cannot be readily assessed. For example, how do we know that a single e-mail or comment is representative of the entire class or at least a reasonable fraction of it? We know a stronger interaction is relevant for learning, and yet it is impossible to interact at personal level with all students of a large group. Hence, we posit the challenge: How to interact with 250+ students?

Assessing: Assessment is a key component of course design, and will have a major influence in student’s learning (Gibbs & Simpson, 2004). Assessing large number of students is though a challenge. It is much less time consuming and enjoyable to assess 30 than 300 essays. In some cases, grading a large number of

essays, exams and oral exams requires a group effort, which increases the demand on coordination work and risks inconsistencies between evaluations. For example, in 2015 we conducted an oral examination of around 200 students. The exam required the coordination of approximately 15 external examiners and faculty members, and was run for seven days fulltime. Thus, educating a large number of students will invariably lead to an assessment problem.

The problem becomes more pronounced as we raise our expectations in terms of the intended educational experience. The so-called student syndrome is a well-identified student behaviour in regards to assessment and deadlines. Student syndrome phenomenon postulates that the amount of effort dedicated to a task increases disproportionately as it gets closer to a deadline, as represented in Figure 3.

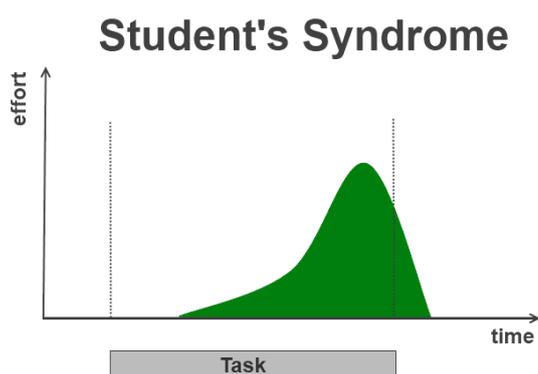


Figure 3: Student syndrome ³

This behaviour decreases learning effectiveness, as it encourages short-term memorisation and cursory engagement with concepts. Provided used with care to avoid overassessment, a mix of formative and summative assessments can be used to distribute workload of the course across time and avoid the student syndrome.

Thus, ideally, there will be not one assessment per student, but several, across the period of the course. In large classes, such approach consume too many resources, and hence hamper our academic and research progression. What other alternatives are there? Do we need to get back to multiple choice exams? If so, how? In summary: how to assess 250+ students?

Motivating: Education research suggests that the motivation to learn and the actual learning is highly correlated with the enthusiasm of the lecturer and the student's perceived relevance of the subject (Cooper & Robinson, 2000; Mulryan-Kyne, 2010). Motivation theory provides us with some other cues to enhance motivation. For example, recent studies like Pink (2011) suggest that autonomy, mastery and purpose are important components in motivating people in workplaces, and such findings can be expected to be reproducible in education. Hence, research thus far suggests that some elements of motivating are idiosyncratic, and hence based on a better understanding of the individual, or the provision of enough options that would cater to a wider variety of interests. As larger groups are more heterogeneous, the differences and sometimes conflicting interests between students become mind-blowing. Catering to such different audiences, while still having a common ground to discuss the content of the course is very hard. How can we make the subject relevant to each student? How can we convey the subjects in the course in

³ Source: <http://www.comindwork.ru/weekly/2015-10-19/productivity/student-syndrome-unproductive-work>

an appealing and interesting way to all different students? How can we show our enthusiasm to students in a large group? In short, how to motivate 250+ students?

Ecosystem: Unlike the other four challenges, the ecosystem is related to the analysis of the course within its larger context. Such context can help or hinder the development of larger classes. The key insight is that education is not confined to the classroom. Apart from the development of the course itself, there is also a need to develop a fruitful context for the development of the discipline within DTU. This includes solid and substantial research, understanding of the needs from practice (and avoid ivory tower approach to education), and provide students with opportunities to practice, research and further develop on the discipline during their studies. Such context is useful as more students become interested in the subject. However, it also means for example, more supervision of master thesis and other student related work, etc. The resources become again a bottleneck, and the coordination of the tasks itself becomes time consuming too. But it also means that we can empower students to develop opportunities for themselves, own and shape their learning journey. Therefore, how to shape the ecosystem of a course to help educating 250+ students?

Overview of our course on project management bachelor education

Before we can discuss how we addressed the challenges discussed above in our course, we would like to provide a bit of context of our course on project management, which we will call from now onwards only 'our course'. Our course is a bachelor 5-ECTS course on project management. It comes in two variations:

- 42430: a 13-week course, which runs in the Spring for over ten years.
- 42429: a 3-week intensive course in August introduced in 2015.

The general purpose of the course is to enable students to participate in projects and critically and appropriately apply project management theories, concepts and tools in practice⁴. Students have unique insights into how project management is practiced through the analysis of a "real" world project that they choose and contact independently. Students are reminded a month before the start of the course that they need to identify a project and contact to project manager, and that this is critical to taking part of the course. Students also experience the role of project manager as each student will be responsible to manage at least one day of the group work, i.e. to be the 'Project Manager of the Day'. A large portion of the class and work takes place in groups.

We organize the course around four central perspectives required for the management of projects: Purpose, Complexity, Uncertainty and People. The perspectives act as a backbone of the course. They are introduced in the first day, and revised by each lecture, developing an increasingly complex and comprehensive picture of what it takes to DO projects.

We evaluate the performance of students by:

1. **Group report** is a written analysis of a real life project. Students are expected to apply tools, concepts, models and theories, both appropriately and critically, to understand the reasons for the project 'success' or 'failure', identify challenges and develop recommendations of a real-life case. The report is divided into two (3 week) - four (13 week) intermediary deliverables spread across the duration of the course. Groups receive peer feedback on intermediary deliverables.

⁴ Learning objectives are in appendices.

2. **Individual peer review** of intermediary deliveries of other group's report. Note, we do not use the peer feedback for grading purpose, but grade the feedback provided by the student. The quality of feedback is used only in cases where the student is between grades.
3. **Individual quizzes**, which take place on regular basis in class, with around 10 multiple-choice questions, which vary in level of difficulty, from simply knowledge and definition, to application and analysis through, for example, analysis of mini-case situations.

Prior to the start of the class, we provide students with course schedule (see example in Figure 5) and course information, a 10-page document with comprehensive description of the course and its various components⁵. As demonstrated in the schedule, the course is deliberately complex and has several deadlines and high workload, so students will need to manage themselves (and each other) to get the work done. Here we provide them with hands-on experience in project management, and stresses the role and need of the 'Project Manager of the Day'.

⁵ Send an email to joasta@dtu.dk to receive a copy of the course information.

Day #	Date	Reading & Preparation (Prior to class)	Lecture, Building 421, Auditorium 73 (09:00-12:00)	Quiz (13:00-13:30)**	(13:30-16)	Intermediate Deliverables (No later than at 19:00)
INTRODUCTION						
01	01.08.16	Choose project case for 'Open Space'	Introduction to the course, and to project management. Open Space & Group Work	X (only exercise)	Group Work	Collaboration Agreement Project Description
PURPOSE PERSPECTIVE (Christian)						
02	02.08.16	Textbook: Chapter 4 & 5; Handbook: Purpose, ISO*: Sections 3.8, 4.3.1 to 4.3.14	Stakeholder, Purpose, Success, Lifecycle	X	Group Work	
03	03.08.16		Group Work			Part 1: Purpose
COMPLEXITY PERSPECTIVE (Joana)						
04	04.08.16	Textbook: Chapter 6 & 8; Handbook: Complexity, ISO: Section 4.3.14 to 4.3.27	WBS, Time Planning, Resource Planning	X	Group Work	Presentation of Part 1 (13:30), Peer Review Part 1
05	05.08.16		Group Work			Evaluation of the Peer Review
UNCERTAINTY PERSPECTIVE (Joana)						
06	08.08.16	Textbook: Chapter 10 & 13; Handbook: Uncertainty, ISO: Sections 4.3.28 to 4.3.31	Risk and Opportunity Management, Control & Change	X	Group Work	
07	09.08.16		Group Work			Part 2 & 3: Complexity & Uncertainty
08	10.08.16	Read 'Project Game' instructions	Project Game (Planning)			Bid
09	11.08.16		Project Game (Execution)			REFLECTION: What does it take to manage projects?
PEOPLE PERSPECTIVE (Christian)						
10	12.08.16	Textbook: Chapter 11; Handbook: People; ISO: Sections 4.3.38 to 4.3.40	Team, Communication	X	Group Work	Presentation of Part 2 & 3 (13:30), Peer Review Part 2 & 3
11	15.08.16	Textbook: Chapter 12	Leadership, Motivation	X		Evaluation of the Peer Review
12	16.08.16		Group Work			Part 3: People
13	17.08.16		Guest lecture (to be confirmed)			Presentation of Part 4 (13:30), Peer Review Part 4
14	18.08.16		Guest lecture (to be confirmed)			Evaluation of the Peer Review
15	19.08.16		SUMMARY: Connecting the dots			
	20.08.16	ISO Certification Exam (optional)				
	25.08.16	Submission of final report				

* Readings based on English version of the book and ISO 21500 Standard

** Grade for quizzes will be calculated as an average from the 4 best out of 5 quizzes undertaken in the course

Figure 4: Example of the schedule of the Project Management Course, 42429 August 2016

Practices

This section describes how we addressed the challenges posited in section 2. At an outset, the course is based on thirteen innovative practices, ten of which were introduced since the Spring 2015. We experimented with different practices, introduced them at different points in time, and developed the course systematically according to our experiences. The course and the story of its development is complex, and while worth sharing, it would detract from the key purpose of this article, which is to discuss practices to educate large classes. We therefore simplified the practices, its context and relationships. Table 1 provides an overview of the innovative practices to cope with increasing number of students.

Practice	Introduction	Challenges addressed	Implementation	Rational for implementation	Actual benefits and unintended 'disbenefits'	Lessons learned
Flipped classroom	Spring 2015	Activating	e-learning based on 10 videos of 5-10 minutes duration per week, connected with quizzes and exercises in class to motivate preparation	<ul style="list-style-type: none"> • Strong student activation enabling on-demand 'consumption' of content 	<ul style="list-style-type: none"> • Students didn't watch all videos, and we had a large drop out, so activation didn't work as planned 	<ul style="list-style-type: none"> • Long time in studio • Lack of interaction with students
Individual quizzes	August 2015 ⁶	Assessing Activating Interacting	Developed into a 10-question multiple-choice quiz to assess individual performance. This enabled us to change course assessment from time-consuming oral examinations to quiz and group reports	<ul style="list-style-type: none"> • Efficient assessment of large groups • Proxy to capture and correct misunderstanding across class and identify students' specific needs • Encourage engagement with all content throughout the course 	<ul style="list-style-type: none"> • Assessment was more efficient • We identified misunderstanding and used the survey itself as a tool to clarify most of it by providing explanations in the survey • It encouraged engagement with all content throughout the course 	<ul style="list-style-type: none"> • Difficult to develop questions that go beyond recall and knowledge • Attention to detail is prerequisite. 250+ students interpret same question in myriad ways
Intermediary	August 2015	Interacting Activating Assessing	Break down of the final report into intermediary deliverables (4 in Spring, 2	<ul style="list-style-type: none"> • Quicker understanding of 	<ul style="list-style-type: none"> • As expected, students mentioned that after first deliverable 	<ul style="list-style-type: none"> • It adds to the complexity of the course and needs to

⁶ First trial was implemented in Spring 2015, and became part of the assessment in August 2015.

deliverables			in August). This is the first step into the modularisation of the content, that can be used by students on-demand	<p>expectations of the report</p> <ul style="list-style-type: none"> • Allow feedback on report and improve sensemaking of expectations • Address group's specific needs 	<p>expectations of the report became clearer</p> <ul style="list-style-type: none"> • After a few trials, we found an effective way to provide feedback to the class • TA used the reports as mechanisms to interact with groups, but it was very time consuming, and TAs required more hours than available 	<p>be as simple as possible</p> <ul style="list-style-type: none"> • Be careful not to create expectation of assessing all intermediary deliverables throughout the course • Be aware of deliverables in other courses might create an overwhelming workload.
Peer feedback	Spring 2016	Activating Assessing	Individual feedback of another group report and their own. Feedback based on learning objectives	<ul style="list-style-type: none"> • Encourage peer to peer learning • Develop ability to provide constructive feedback • Exposure to how other groups developed their report • Understanding of the learning objectives and expectations of the course 	<ul style="list-style-type: none"> • Encouraged peer to peer learning • Based on interviews and sampled assessment, the students improved ability to provide constructive feedback • Students were exposed to how other groups developed their report • Students understood the learning objectives and expectations of the course 	<ul style="list-style-type: none"> • Students complain of heterogeneous quality and contradiction between feedbacks and some perceive it as a 'waste of time' • Impossible to use as an assessment method to all students • Analytics can back fire: features such as 'likes' and 'flags' were abused by some students. However these practices can be isolate using the advanced techniques.
Project game	August 2015	Activating Motivating	Game where students plan and execute a	<ul style="list-style-type: none"> • Provide opportunity for students to 	<ul style="list-style-type: none"> • It worked. The project game provided 	<ul style="list-style-type: none"> • High need of resources and

			<p>project, and can apply concepts learn in theory and experience challenges across the four perspectives of the course.</p>	<p>experience project management and apply tools and concepts learned in class</p> <ul style="list-style-type: none"> • Motivate students to engage in projects 	<p>learning opportunity, but it was difficult to balance complexity to look like a real project and simplicity required to 'play' it in short period of time.</p> <ul style="list-style-type: none"> • Motivation worked for most, and the game has been well rated overall. However we had a problem with software coding in one of the implementations which led to some frustrated students 	<p>coordination to run the game work with large number of groups</p> <ul style="list-style-type: none"> • Small mistakes in code or instructions have wide consequences, and can jeopardise the learning experience • A TA interested and involved in the game development is extremely useful • Game can be a good place to observe project behaviour and do research (data collected and paper is being produced based on the game)
<p>Practices for interaction whilst lecturing</p>	<p>Spring 2016</p>	<p>Interacting Activating</p>	<p>Several small exercises to do in class taking advantage of the large number of students, such as debates, socratic and google form quizzes and mini-cases</p>	<ul style="list-style-type: none"> • Stronger interaction with students in class • Students feel part of the class and experience some of the concepts 	<ul style="list-style-type: none"> • There was a stronger interaction with students • Students feel part of the class and experience but only for a few examples. We had to juggle also time that such exercises consumed 	<ul style="list-style-type: none"> • Not all subjects and all classes lend themselves into such practices • Interaction with student is still very controlled and allow limited input on their side • Creative work, and partly time consuming (but actually fun) • Good to have, should not take the attention

						away from preparing other aspects of the class
Frequent evaluation of the class, and act on it	Spring 2016	Interacting	Student evaluation of the course not at the end but by the end of each perspective (module), and search for honest conversation with students throughout the course. We acknowledged and if meaningful, reacted to the suggestions and complaints as soon as possible.	<ul style="list-style-type: none"> • Open communication about the course with students • Ability to develop the course during the course, instead of at the end of it 	<ul style="list-style-type: none"> • Students perceived they were being listened to, and valued our openness to their concerns and needs • We could develop the course while running it, making it more relevant and feasible to the cohort (at least in Aug 2016) 	<ul style="list-style-type: none"> • Difficult to judge the difference between individual opinions and genuine problems that impact large proportion of the class • Time consuming and difficult to implement changes on the top of an already very complex course
Global challenges	Spring 2016	Motivating	We systematically encouraged the students to consider projects as a vehicle to change our society, and address global challenges. Specifically, they reflected on how their projects address the UN Sustainable Development Goals (SDG), and prepare a slide of their own projects. The course closes with a video clip with the slides organized around Beyonce video clip 'I was here'.	<ul style="list-style-type: none"> • Encouraging students to reflect on the ethical dimension of projects and their role in it 	<ul style="list-style-type: none"> • We hope this helped them reflect on their role in society and the importance of the projects they choose to participate, and hence introduces an ethical component to the course. It takes place throughout their lives, so we cannot evaluate it 	<ul style="list-style-type: none"> • The video at the end is a big surprise and provide a golden closure to the course
Danish Standard (DS)	Spring 2013	Motivating	Collaboration with the DS so students can take an extra-curriculum exam	<ul style="list-style-type: none"> • Helps students in their career prospects in projects 	<ul style="list-style-type: none"> • It may help students in their career there are several examples 	<ul style="list-style-type: none"> • Overall, well received by students and industry

Certification			and become certified project managers	<ul style="list-style-type: none"> Increases profile of the course and student's focus and dedication to it Links with the course objective which is to educate students to participate in projects, and hence learn project common language which is represented in the standard 	<p>that some students have got a job because of the certification. However, it is difficult to assess the long-term impact.</p> <ul style="list-style-type: none"> We hope this was a contributor to increasing profile of the course and student's focus and dedication to it Many students took the opportunity, and were successful, hence learning the common language of projects as required by the extra exam 	<ul style="list-style-type: none"> Requires extra work and more coordination
Real-life case analysis	Always part of the course	Motivating Activating	Described above	<ul style="list-style-type: none"> Compare theory with real-life project management practices Personal contact with project managers and a project Tailor the course to their interest and specific project context 	<ul style="list-style-type: none"> Relationship with real life project management makes concepts more relevant and better understood Students are capable to find their contact and managing themselves Students were able to choose their projects 	<ul style="list-style-type: none"> Real life projects are complex. We still have difficulties to improve students' critical analysis of the project practices, some tend to be too descriptive or too simplistic
Open Space	Always part of	Activating Motivating	Process for group formation inspired by the energy and dynamism	<ul style="list-style-type: none"> Identification of real life cases relevant to 	<ul style="list-style-type: none"> Student's manage to identify possible case opportunities. 	<ul style="list-style-type: none"> Creates an interesting course since the cases always are different

	the course		that typically occur during breaks at conferences where people, who may not know each other, create networks, share knowledge and generate ideas for future cooperation.	<p>the students interests and specializations</p> <ul style="list-style-type: none"> • Formation of groups around the most popular opportunities 	<ul style="list-style-type: none"> • The groups are always formed although the process appear as chaotic. 	<ul style="list-style-type: none"> • Needs facilitation by supporting the group formation process • The open space process resembles the practices of living in a project society
Project Manager of the Day	Spring 2015	Activation	Described above	<ul style="list-style-type: none"> • Opportunity to experience managing others • Receive feedback from group members supporting personal reflection and development 	<ul style="list-style-type: none"> • Overall good experience when it worked. Some students report having reflected and developed themselves through the experience • The different feedback processes was tried out but it was hard to identify how it worked. 	<ul style="list-style-type: none"> • Difficult to reinforce, particularly if there is no push in terms of assessment, but it is also difficult to assess their own experiences and it would add yet another level of complexity to the course

Table 1: Overview of the practices

Ecosystem: learning beyond the classroom... a fruit full context for learning

Learning is not confined to the classroom. This may appear like an obvious remark, but it takes effort to develop and tap into the potential of the learning ecosystem. In other words, when we talk about the ecosystem, we don't only mean that the context should be taken into consideration, but also that we as lecturers have to shape the context, when possible. Regarding our course, we are acting on three aspects of the course ecosystem.

First, some constraints we had limited impact. Our course needs to connect with the broader context of teaching at DTU. We faced this challenge in the Spring course, as students are taking in average 4-5 course in a term, and the deliverables and deadlines will collide with priorities of other courses. Thus, the activities needs to be seen in a bigger picture to optimize the workload. The complexity of the course is fundamental, and requires student close attention and management. Some students are very good at managing and pacing themselves, but that is not always the case. However, our course run across several study lines, and hence diverse combinations of courses taking place together. Thus, the coordination of operational level is challenging for large, and in particular, very heterogeneous courses.

Second, as argued in the introduction, project management is the second most important competence of an engineer. We not only struggle with large numbers in our class, but we also argue that many students if not all students would benefit from development of competencies in professional project management. And as we mentioned in the introduction, projects are a vehicle to deliver benefit to society, and hence, embedded in DTU's mission. One way of increasing the size of the 'class' as well as our outreach is to extend the learning to the context. Indeed, one of our key 'selling points' has been to extend the space and time for learning, practicing and researching projects beyond our course. Projects are embedded in several activities of students throughout their time at DTU. Actually, looking at it from project organizing perspective, DTU holds large portfolios of projects, such as blue dot projects, group work, bachelor and master thesis, etc. Thus, students require project management for their studies (and lives). We remind the students of that throughout our course, and would like to continue tapping into this demand by developing a concept box for projects, which can be used on demand, as well as a very quick crash course on projects available to all DTU students.

Third, we launched the ProjectLab, which is a hub of practice and research of projects, programs and portfolios at DTU. Among other things, we aim to extend our outreach by providing and making students aware of the myriad of activities to practice and research projects. These are some examples of other initiatives we are leading within the ProjectLab:

- We established the practice meets theory seminars series we organize with practitioners for students in collaboration with PMI
- we established the P3M Industry Advisory Council to discuss learning practices with senior executives and project practitioners
- We are developing the crash course in project management (under development)
- We are developing our own handbook for the course commissioned by Danish Standards
- We supervise over 5 PhD students in the area of project, program and portfolio management
- Over 20 master thesis each year
- We are developing a project wall in 303A (under development)

In conclusion, the ecosystem does not have to be a challenge in large courses. However, our experience suggests that a) it can take some of the pressure out of the course itself in terms of developing skills and competencies by providing other forms of engaging with the subject beyond the class and matching

ambition and level of student (and hence catering the heterogeneity of large groups); and b) that the context can help create importance and relevance to the subject of the class.

Discussions and suggestions for fellow scholars

This section explores the relationship between our practices and experiences with that of others and make a few suggestions for fellow scholars educating large classrooms.

The developments of our course have been guided by Schön's concept of reflective practitioner (Schön, 1983), not only in terms of reflection of our own practices, but because we would like to help students to developed a reflective relationship with their project practices during their studies at DTU and beyond. The arguments related with the key challenges have been in line with some of the leading theories on large classes or general higher education. In particular, Biggs's focus on what the student does as oppose to what we do as lecturers has been particularly central to our practices. Hence, we attempted to develop activities and context that are problem-focused and allow students to actively engage with the subject (Biggs, 1999). All activities related to 'activation' and most related to 'motivation' were following this line of thought.

Our myriad innovative practices to cope with the increasing number of students in the classroom was inspired by reading in the literature on learning and education, as well as other related areas and prior experiences and observations of peer lecturers and professors. We choose to discuss only two practices and their embeddedness in literature: practices in activating and interacting with students in large classrooms, and gamification. The rational for this choice is that many of the other practices have already been dealt with in further detail in other parts of this conference.

First, regarding the practices for interaction in large classrooms have been inspired by practices we have seen and read in other places. For example, lecturers of Michael Sandel, the Harvard professor in political philosophy were inspiring. His lecturers were so appreciated, that they became a BBC TV-series called Justice – what is the right thing to do? Despite a very large audience (which now spans beyond the crowded lecture hall at Harvard), Sandel creates a relationship with students, and engage them in active reflection through questions and problem based lecturing and on spot debates between students. The method obviously works, he was able to engage not only his own class, but large audiences, only based on a 1 to many lecturing.

Morton (2003) shared another inspiring example, where a lecturer in globalisation asked the students to take off their shoes, look up the label, and place a post-in in a large world map. The students could then experience that most shoes came from somewhere in Asia, and that was the kick off of a discussion about globalisation and its consequences.

What we found particularly insightful about these practices is that they not only engage a large number of students, but it benefits from the large numbers, which is something useful to consider for any peer academic engaging in large classroom 'teaching'.

Second, we were inspired by the 'movement' on gamification of education. One of the authors conducted professional games before with executive MBAs, and would like to develop similar experience to bachelor students, with far less experience. We developed our own game, but there are many professional games available in different disciplines, and some are even freely available. This development was interesting also in terms of research. One of the researchers collected data for preliminary studies on behavioural decision making in project contexts, and became involved in a large EU funding application on gaming in education.

Thus, our practices have been partly inspired, partly backed up by theories and practices in different contexts in higher education.

Learning Journey and Evaluation

Now we come to the crucial question: did we manage to educate 250+ while progressing our academic career?

First, the application of these theories and inspiring practices into our classrooms and education practice has not been straightforward; it required dedication, imagination and experimentation, which is challenging to reconcile with an active research career. Having said that, we published 19 articles, including three journal articles in the past two years, submitted a few research proposals and attracted external funding. Thus, our academic careers remain prospering, however, at cost of high stress and limited work-life balance.

Our course has improved in many ways as well, and we definitely learned throughout the process. We have been brave to implement different innovative practices. Some worked well, others didn't. We learned from them and improved our course accordingly.

However, we are not there yet. Figure 6 shows the number of students from 2012 to 2016 (bars) and student evaluation (lines). As one can see the number of students increased in 2014, and students evaluated the course very positively. In 2015, we started changing it, and implemented e-learning. We got back on track in the intensive course in August with only around 50 students. However, perception of students on the course did not improve in 2016, where we implemented peer feedback (which was not widely well-received). We mitigated the issues, and managed to implement a very successful course in August. Student evaluations were 4.3, and we are very satisfied with the results. However, we had 'only' 75 students. The question remains: will we be able to replicate the results to the large group next spring term?

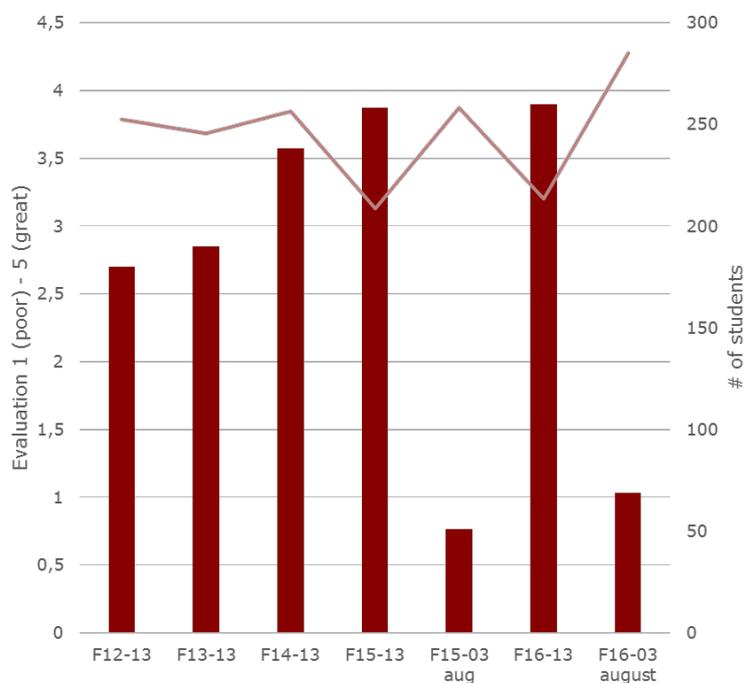


Figure 5: Student's evaluation and number of students

Comments referring to the August 2016 version of the course:

Positive student comments	Negative students comments
<ul style="list-style-type: none"> • It is really an awesome course. Keep going. • This is the first time I attend lectures at DTU where the lecturers are not trying to relay a un-absorbable amount information, whilst still managing to talk at a reasonable pace. - You clearly take the listeners, and human learning ability, into consideration in your lectures - if you were ever to start a movement at DTU (the TED video) could you please do so amongst your fellow lecturers..? • Everything was perfect! except peergrading :) • This is basically the best course I've had on DTU. Please remember to learn your colleagues how to give the students "breaks" from slides, through active discussions of the theory. Very well composed course. Great use of PP slide decks, in order to get the groups talking - good to form a basis through the learned theory, while taking a break form the compact lectures. • Internal hand in deadlines are good to ensure, that we dont get behind schedule. Both Christian and Joanna have a great energy and explains the material well. • The schedule of the course is very clearly, so I can follow it to make some preparation. • Course materials are great and awesome. Cannot ask for better. The game makes the theories understandable how to use in practice. 	<ul style="list-style-type: none"> • Though it is a 3 week course, It could easily include one more week and be less "in a hurry" This way the original planned workload, and the activities such as giving feedback and writing the report would be better distributed. The group formation could include other techniques instead of the poster • Maybe a bit to much useless information in the slides • Too many trick questions in the quizzes. Don't show videos during the classes, they are only time consuming. • The T.A. comments were very helpful, much more so than the peergrading. • Long lectures with more content than the timeframe practically allows, removes the practicality of having the afternoon for group work.

Table 2: Examples of student feedback to the August course 2016

Conclusions

The purpose of this article was to discuss challenges and approaches to a *educate* large number of students while progressing academic research-based *career*. In other words, we take the challenge of educating large number of students as oppose to 'lecturing' them, and would like to do this in an effective format to enable space for a research-based career. We set up to challenge therefore some of common practices, believes and even extant evidence in teaching large groups. But we were guided by inspiring cases, and research that suggested such possibility exists.

We addressed the topic by first reflecting on the key challenges posed by teaching large classrooms. The reflection resulted in four key challenges: activating, motivating, interacting and assessing students, as well as a close consideration and potentially development of a fruitful ecosystem in which the course takes place.

We then analysed on our experience and innovative practices in the course 42430/42429, a 5ECTS basic project management course at bachelor level, which educated over 320 students alone in 2016. The course is particularly suitable as it has been conducted in a very similar way, and same content in large classes of 250+ and smaller classes of around 60 students.

The framework has proven useful for the analysis of our practices. It also points to the well-known need for holistic course design. As an attentive reader could have noted, there is a strong relationship and partly some trade-offs between the different challenges. Thus, while considering the different elements separately is relevant to understand the nature of our challenge, it is also relevant to consider how solutions to the different challenges work together.

Our initial framework provides an incipient attempt of descriptive theorising on the challenges involved in educating large classrooms. The four challenges and ecosystem are developed inductively, based on our reflections, readings and practice, and requires further development.

Indeed, this essay has its problems and faults like most papers. We have focused more on description of challenges and practices than in systematically reviewing the field or critically engaging with literature or our course holistically. We hope some will be in agreement, and some may find it even inspiring. Some might disagree and our hope is that such disagreements will trigger debate and discussion about the current state of our field and its future trajectories.

Appendix: Learning Objectives

Learning objectives: A student who has met the objectives of the course will be able to:

1. Appraise the relevance of projects to engineering practices
2. Understand and critically assess the nature of projects based on four key perspectives (purpose, complexity, uncertainty and human behavior)
3. Identify and describe typical mistakes and good practices in the management of projects
4. Apply appropriate tools, concepts, models and theories to analyze cases and real life projects
5. Apply appropriate tools, concepts, models and theories to explain project success and failure
6. Apply appropriate tools, concepts, models and theories to make practical recommendations
7. Compare project management theory and practice and discuss its strengths and weakness in general and in relation to cases and real life projects
8. Communicate clearly, concisely and based on evidence

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