Improving University Science Teaching and Learning

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Contents

Preface

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This is the 13th volume of the Department of Science Education's series of anthologies based on participant's development projects made in relation to the Teaching and Learning in Higher Education programme ("Univeristetspædgogikum" or UP) at the University of Copenhagen. The series is published in both hard copy, print-on-demand at lulu.com as well as digital versions, which can be downloaded from the webpage of the Department of Science Education under publications. It is possible to search through previous projects in the anthology by using the local search engine found here: http://www.ind.ku.dk/publikationer/up_projekter/.

This volume consists mainly of project reports written by participants from the August 2017 course. Each participant is required to conduct a small-scale development project as part of UP. The projects show how individual teachers have identified specific problems relating directly to their teaching practices and includes their reflections on how to develop their practice and the quality of teaching more generally.

Topics covered in the projects include course design and redesign, constructive alignment, research based teaching, feedback to name a few. This anthology is organized into parts based on some of the recurring overarching topics to give the reader a structured overview.

We would like to thank all the authors for their valuable contributions to the promotion of Scholarship of Teaching and Learning at the University of Copenhagen.

Part I

Research based teaching and learning

1

Innovative approaches to research-based learning

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Introduction

University educators are tasked with developing students equipped for real-world problem solving while also delivering research-based-solutions for pressing real-world challenges such as climate change, urbanization, human health and wellness (Styrelsen for Forskning og Uddannelse, 2017). This is specifically the case in professional educations such as Landscape Architecture and Planning where students are expected to make an immediate contribution to the job market and university researchers in this field are expected to deliver innovation (Griffiths, 2004). These intersecting demands have led some to call for research-based learning as a central tenant of university teaching (Brew, 2013; Dohn & Dolin, 2015; Tight, 2016). Research-based learning is broadly defined as teaching that uses research as a pedagogical tool for knowledge output, and it has been shown to produce direct benefits and co-benefits for students and teachers (Brew, 2013). For example, research-based learning is shown to directly engage students in real-world research problems and results by actively applying a field's theory and methods to a known problem (Dohn & Dolin, 2015). In this regard research-based learning has the possibility to bridge the gap between theory and practice, exposing students to critical inquiry in the field while giving teachers the opportunity to engage students in data collection. Co-benefits of research-based learning include engagement with partners in the public, private and NGO sector, the leveraging of class-room knowledge in a real-world setting, and the profiling of a research field through innovative, solution-based results (Griffiths, 2004; Healey, Jordan, Pell, & Short,

2010). Yet questions have been raised regarding the impacts of research-based learning with some suggesting that the combination of research and teaching is at best ineffective and at worst, impossible (McKenzie, Griggs, Snell, & Meyers, 2018; Stappenbelt, 2013).

Moving forward it is critical to consider the benefits as well as the potential challenges that accompany research-based learning, specifically regarding its impact on student's learning in terms of innovation and solutions-based knowledge. *This article takes up this discussion by asking how a research-based approach to teaching mediates learning and knowledge production in the field of Landscape Architecture and Planning?* This is done by drawing on the results of two years of research-based teaching in the MSc course Urban Forestry Urban Greening taught at the University of Copenhagen. First the learning outcomes and pedagogical approach of the Urban Forestry Urban Greening course are introduced. This section engages theories of research-based teaching and innovation to demonstrate how the course pedagogy is aligned with principles of research-based learning. Following, the results of the course projects with the Municipality of Copenhagen from 2016-17 and 2017-18 are presented. The article concludes with a discussion regarding the impacts, benefits, and co-benefits of research-based teaching in Landscape Architecture and Planning.

The research-teaching nexus in Urban Forestry Urban Greening course

The MSc course Urban Forestry Urban Greening at the University of Copenhagen (UCPH) is offered to Landscape Architecture and Nature Resource Management master students. This course challenges students to shift perspectives from the spatial to the political and is a problem- and knowledge-based course drawing on relevant real-world urban green space governance cases from the Danish and international context . The course explores international literature and Danish cases as an introduction to the planning, management, and governance of urban green infrastructure.

Urban Forestry Urban Greening is an obligatory course for students enrolled in the green space management specialization track of the MSc Landscape Architecture program at UCPH. As Landscape Architecture and Planning is a professionalized discipline, students are expected to attain knowledge and core competencies which translate directly to demands in the job market. These competencies include:

- the ability to shape the planning and management of landscapes such as urban space and landscapes
- This should be done with a view to developing the architectural and environmental values on the basis of a basic knowledge of aesthetic, biological, social, technical and management-related conditions.

The Urban Forestry Urban Greening course supports the development of these core competencies through a research-based learning approach by providing a structured theoretical introduction to the diverse governance (planning, maintenance, management and steering of decision making processes) approaches to urban green infrastructure such as parks, street trees, community gardens, green roofs. Teacher-led theoretical lectures and classroom exercises are balanced by student-led inquiry in the field (Dohn & Dolin, 2015). Students are introduced from the beginning of the course to a real-world case with a broad and un-defined problem. This assignment builds off of the principles of problem-based learning, whereby course activities and assignments use a problem as a stimulus and focus for student activity and learning (Brew, 2013). Through field work, interviews, mapping exercises, policy review, and GIS analysis, students self-define the problem in the case and subsequently weave and bridge theoretical material into a solution-oriented product for a client (usually the Municipality of Copenhagen) in the form of an urban green space management plan. Students in the course acquire both existing knowledge and develop new knowledge through research-based data collection in the field which aligns with what Levy and Petrulis (2013)coin as "inquiry-based learning." Research-based learning takes place both independently through student-led reading and exercises as well as in course assigned groups for the final assignment. Ultimately the research-teaching outcomes of the course are student-focused with the instructor (myself) selecting and structuring the base content of the course material and course knowledge outcomes while students are tasked to define their problem, research question and methods for analysis in the creation of their course product. This dynamic approach to research-based learning draws on Brew's (2013) "wholistic model for research-based learning."

Additionally the course focuses on linking the outcomes and attributes of research-based learning with the current demands of the job market in the Landscape Architecture and Planning industry. An innovative approach to university pedagogy assumes that students learn most by taking an entrepreneurial approach to learning, meaning that the student will develop

their own innovative ideas for green space management by learning how to initiate, manage, and support new processes for improved organizational performance (Nabi, Walmsley, Liñán, Akhtar, & Neame, 2018; Samuel, Donovan, & Lee, 2018). Innovation in this case is defined as the act of making changes in learning outcomes and knowledge development, by introducing new methods, ideas or products to the learning process (Nabi et al., 2018). In the Urban Forestry Urban Greening course, students are encouraged to learn innovatively by developing and refining a problem in our real-world case. They are then tasked with designing solutions that fit the municipality's expectations and they must obtain buy-in from key stakeholders such as community members. While our course client, the Municipality of Copenhagen, initially identifies the broad problem and knowledge-gap for the course to address, the students are tasked with developing an idea or concept that provides a novel approach to the problem solving. This innovative approach to research-based learning provides an ideal testing ground for the theoretical concepts introduced in the course and students are challenged to adapt or modify the concepts for problem solving. The course aims to facilitate innovative processes in a research-based learning environment where a student-generated hypothesis is tested out (inductive learning) or generated through teacher and client-selected workshops and interviews (deductive learning) (Samuel et al., 2018).

Outcomes and attributes of course partnerships with the Municipality of Copenhagen

Thematic context

The point of departure for the research-teaching nexus in the Urban Forestry Urban Greening course has been analyzing and learning from the challenges and opportunities surrounding urban re-naturing and climate resilience. From 2016 to 2018 the course has focused on the Municipality of Copenhagen as a critical case area.

The "re-naturing" of cities has come to the fore-front of urban planning the world over. From Singapore to Copenhagen, city leaders have implemented large-scale tree planting campaigns and the greening of post-industrial sites with urban parks and community gardens. Some of the core questions dealt with in the course have included 1) why are green spaces so important for today's cities and towns? 2) how do we develop sustainable

and multifunctional green structures that meet the expectations of local citizens, politicians and other diverse interests? 3) how can green spaces and trees provide nature-based solutions for a climate-resilient future? Working with a Nordic and international perspective, students are challenged to conceptualize and apply key concepts, theories, and methods involved in the governance of urban parks, woodlands, street trees, community gardens and other green areas.

Urban Forestry Urban Greening course work 2016-2017

Research-teaching attributes: structure and line of inquiry

In 2016/2017 the students in the course worked with the Municipality of Copenhagen's urban renewal process in the Sundby neighborhood of Copenhagen. Students were tasked with improving the socio-cultural potential and flows in Sundby's urban nature while addressing the green infrastructure potential of Copenhagen as the core course problem. The task was semi-structured as students were requested to use mapping as a dominant methodology and they were requested to contextualize their line of inquiry in Copenhagen's green infrastructure and climate adaptation processes. Students began their process with intensive lectures and field visits including interviews with community members and community councils. The students also organized a formal meeting with citizens and the two local community councils to identify place-based values associated with urban green infrastructure in Sundby.

Research-teaching skills: outputs, knowledge, and audience

The large size of the site area in combination with the complexity of the course problem meant that students worked on various levels/scales simultaneously to interrogate multi-level governance perspectives. Some students chose to focus on specific typologies of the built environment such as heavily –trafficked streets vs. neighborhood green ways while other students chose to identify traditionally-overlooked informal urban nature types that the municipality had failed to document in their own urban nature strategy. The student's final product resulted in 4 excellent strategies focused on diverse concrete objectives and initiatives that could be implemented in the Sundby 'kvarterplan'at the end of 2017.

The results of the student's work was presented at the beginning of 2017 to the city of Copenhagen's architect Tina Saaby and her staff working with the urban renewal process in Sundby. Additionally 10 members of the local councils attended the students' presentations. This successful dissemination of the students' outputs resulted in several of the student's data collections and concrete objectives and solutions being integrated into the official Sundby kvarterplan (Københavns Kommune, 2017). City officials continue to contact myself and the students from the course for knowledge and insight into the Sundby community planning process.

Student evaluations of the course and the course project were on the whole very positive yet several remarked that the complex scope of the project site and challenges was incredibly difficult to work with in a 8-10 week frame. Time and inexperience challenged the students and most of the students I interviewed following the course wished that they could have continued working on the project in their Block 3 course.

Urban Forestry Urban Greening course work 2017-2018

Research-teaching attributes: structure and line of inquiry

In 2017/2018 the students in the course worked with the Municipality of Copenhagen's partnership tree program, an initiative started by the municipality to give trees away to citizens to plant and steward on private land. The students were tasked with assessing the program with a focus on the short-and long-term consequences of developing and managing urban nature with citizens. The task was semi-structured as students were given a case area, the Islands Brygge neighborhood of Havnevigen and the broader neighborhood of Amager Vest. Students were also requested to contextualize their line of inquiry in Copenhagen's green infrastructure and climate adaptation processes. Students began their investigation with intensive lectures and field visits including interviews with community members and the chairwoman for the local neighborhood council. The students organized an on-line survey sent out to community members to identify place-based

values associated with partnership trees and urban green infrastructure in Havnevigen, IslandsBrygge, and Amager Vest.

Research-teaching skills: outputs, knowledge, and audience

The micro to macro scale of the site(s) in combination with the open-ended nature of the course problem meant that students took diverse approaches to how they worked with scale and governance perspectives. Some students took a close-read perspective of the micro site, Havnevigen, delving into the various user profiles of residents and categorizing nature preferences by age, education, income, and recreational activity. Other students took a macro perspective using Havnevigen as one case site in reference to other cases with diverse scales, socio-economic make up, and urban nature typologies. The students' final product resulted in five innovative strategies focused on diverse concrete objectives and initiatives that could further develop the municipality's partnership tree program.

The result of the students' work was presented at the beginning of 2018 to the city of Copenhagen's strategic planners for urban nature and climate adaptation. Additionally two of the student projects were selected by the municipality for potential implementation and are currently under review by municipal planners and the manager of the partnership tree program. Two students from the course also presented the results of their course work at the European Forum on Urban Forestry, an annual international conference for researchers and practitioners in the field of landscape planning and management. This successful dissemination resulted in the student's research-based learning impacting at the local and international level.

Student evaluations of the course and the course project were positive yet several remarked that, in contrast to the previous year, the chosen scale of the project site was too small and the topic challenge too narrow. From a teaching coordination perspective, I found that the students' work was excellent and exceeded that standards of the year before, indicating that the scale and scope of the project was probably more appropriate for the 8-10 week teaching/learning time frame in the block schedule.

Discussion

This essay has explored the benefits as well as the potential challenges that accompany research-based learning, specifically regarding its impact on

student's learning in terms of innovation and solutions-based knowledge. An analysis of research-based learning in the Urban Forestry Urban Greening course at the University of Copenhagen shows that students gain many benefits from the teaching-research nexus yet are challenged by limitations regarding scope, time, and inexperience. These findings align with the existing literature and point towards future steps of inquiry and potential advocacy for the value of innovative university pedagogy.

Benefits of research-based learning

The literature suggests that by engaging students in real-world research problems, students will successfully be able to bridge the gap between theory and practice drawing on critical inquiry, theories and methods in the field while producing innovative data (Brew, 2013; Dohn & Dolin, 2015; Nabi et al., 2018; Samuel et al., 2018). Students in the Urban Forestry Urban Greening course acquired theoretical and industry-specific knowledge related to the combination of public administration, landscape urbanism, green space management, and governance. They drew on relevant models of urban green space management and governance to explain and challenge the role of a public manager within a basic democratic system. They also reflected upon the different user groups, their wishes and needs, and possible conflicts between different user groups to describe and challenge the different organizational levels in a typical green space management organization, including the roles of the different parts of the organization. Additionally, they summarized and complicated the various benefits of urban green spaces. All of this data was used to create diverse urban green infrastructure management plans for the Municipality of Copenhagen.

Students additionally gained skills relevant both for the classroom and the workplace such as reading and analyze peer-reviewed scientific publications and presenting the applied results of their analysis before students and industry actors. Their classroom analysis prepared them to select and asses relevant information for the course project to discuss central tools, their scope and values in relation to green space management and to develop a Green Space Management Plan, including both short and long term visions and related means to fulfill the plan. Through their research-based group work, students learned to independently develop a line of inquiry, to cooperate effectively in a multi-disciplinary and multi-cultural group with a common project, and to apply the course theory to related subjects and/or to different work situations, e.g. in other countries.

Co-benefits of research-based learning

The literature also suggests that research based- learning provides the co-benefits of engagement with partners in the public, private and NGO sector, the leveraging of class-room knowledge in a real-world setting, and the profiling of a research field through innovative, solution-based results (Griffiths, 2004; Healey et al., 2010). Through the research-teaching nexus in Urban Forestry Urban Greening students achieved just this. The course pedagogy is closely linked with the Landscape Architecture industry to ensure that students are shaping their learning outcomes in line with the current demands of the job market. The Landscape Architecture industry is very dynamic in that it is heavily influenced by trends of economic growth or stagnation. Additionally, demand is based on popular approaches to climate change mitigation and adaptation which shifts based on government and industry strategies and standards. In this regard, it is necessary to take a flexible and innovative approach to the course development to ensure that the course learning outcomes match those of the industry standards.

The innovative approach to pedagogy in Urban Forestry Urban Greening crafts strong industry-based learning outcomes for the course thus better aligning the student learning process in the course to the overall aims of the MSc Landscape Architecture education and the dynamic shifts in the Landscape Architecture industry.

Students have been challenged by short timelines for engaging problems, collecting data, and continuing their learning. Moving forward I would like to further engage my students in the process of developing and refining an idea, designing solutions that fit customer/client expectations, develop business model concepts, and obtain buy-in from important stakeholders to better scale their approach to our block-structure learning timelines. Such an approach also necessitates close partnership with a municipal and or industrial partner/consortium and is ideally problem-based. In this scenario the client (municipality or private organization) will identify a real-world problem and knowledge gap and then provide students with the basic materials to work through the problem by developing an idea or concept that provides a novel approach to the problem solving. This problem could be further addressed through an independent study project and or the student's thesis work. This strategy would provide students with more time to further test their line of inquiry, gather data, and adapt or modify the concepts for real-world problem solving. Such an approach would facilitate creative processes in a long-term research-based learning environ-

ment where a student-generated hypothesis could be tested out (inductive learning) or generated through teacher-selected workshops and interviews (deductive learning) not only in a short block-course but through an internship and or thesis. This would provide opportunity for both students and the teacher to profile their work and raise the value of university pedagogy and teaching outputs in the eyes of students, university administration, and industry.

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2

Research Based Teaching in Mathematical Logic

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Introduction: Teaching and Research

According to Humboldt (Humboldt, 1997), the defining responsibility of universities is their role as places of scientific research. Here, scientific knowledge is created, a type of knowledge which is "to be viewed as something not yet completely found, and never to be completely found." Central to the research profession is "with this in view perpetually to aim to find it" (Humboldt, 1997, p. 120; translation by present author).

The competence required for this can only be learned by participation. Oevermann (2005), following Weber (1985), further characterizes this competence as a *social* competence, the *habitus* of a researcher, and interprets the teaching task of universities as follows: that "students act as researchers to become professionals," that is, they learn by participation in a community of researchers.

Healey and Jenkins (2009) stress that research based teaching should apply to every student of a university. Indeed, in a society in which policy and by extension, our further existence on this planet depends on scientifically informed public discourse, there is no getting around universities' responsibility to provide their core service to each student and not just the select few who 'make it' into higher curricular levels such as a PhD-program.

Healey also argues that in practice, students do not regularly participate in research related activities at all. We shall in the following argue that at least in the teaching of mathematics, certain traditions prevent them from doing so, and present a case study in designing lectures to address the issue. I shall begin with a highly exaggerated account of these averse traditions.

The Blackboard Lecture: A Caricature

The epitome of teaching in mathematics is the *classical blackboard lecture* – delivered flawlessly by a superhuman[1] professor who lays down beautiful formulas on the blackboard at the same time as he (of course he is male!) magically brings them to life with explanations. Truths seem to unfold according to their own, innate rhythm. Just as in Euclid's Elements, these truths concern a timeless universe of abstract entities (not, say, a world of diverging strategies and decisions). The student's role, in contrast, is merely to nod to a series of unquestionable definitions, theorems, and proofs.

When the professor is done with his performance, lesser beings take over to drill the student in an exercise class, for application and practice are secondary to the pure, deductive theory.

Lecturing is described in a similar vein in Mazur (1997), where it is also related to very ancient traditions such as a priest's sermon. A remarkably persistent tradition, then – perhaps all this is a re-telling of the story of Zosimo of Panopolis and his student Theosebeia? Upon complaining that she cannot understand the alchemical teachings he intends to impart on her, she is shut down with the words "I gave you what you need to know, and this should be enough for you" (Abt and Fuad, 2012, fol.38b.3-5).

What is wrong with this picture?

So why shouldn't the student proceed from passively listening in lecture, to developing their problem solving capacity in exercise classes, to finally becoming a researcher in the six months or so it takes to write a thesis (if they get that far)?

While a lucky few do take this road, the problem is that most of this curriculum has nothing to do with science in the true sense of *knowledge perpetually in the making*. Firstly, it is not even *about* science in this sense. More crucially, learning *about* science does not seem to impart the competence of being a researcher: According to Mazur (2017) as well as Törnquist (2015), this traditional approach encourages or at least allows bad study habits such as rote learning and a mechanical approach to problem solving. Significant for science in the true sense of *knowledge perpetually in the making* is not possessing knowledge but rather a *type of activity* requiring

[1] This view of academic habitus is starkly contrasted with behavior exemplifying a researcher's attitude by Busch, 2001.

a competence that can only be learned by participating in a community of practice.

Research involves *all* the complementary aspects which are so often described as knowledge, skill, and competence; all of these are all different dimensions of what it means to *act* as a researcher.

In other words, theorems and definitions are not to be viewed as inert book-knowledge, inhabiting an abstract sphere as objects of mathematical knowledge. They are no more and no less than research stopped in its tracks, deposited between strata of pages, but ready to pounce the instant a research mathematician finds a new way to use the tricks, the strategies contained in them. This is one way to interpret the aphorism (attributed in Ulam, 1976, p. 203 to Banach): "Good mathematicians see analogies between theorems or theories; the best see analogies between analogies."

Neither are mathematical problem solving skills to be viewed as the capacity to carry out any one in a certain repertoire of algorithms; rather, we aim for the capacity to solve problems hitherto *unsolved* or even *unknown*.

It is outright irrational to expect students to evolve the competence to act as a researcher in the last, short phase of a curriculum whose bigger part encourages them to act precisely in an opposed manner. Therefore, I tried to incorporate *activities characteristic of research* into my lecture course.

A Research Based Classroom

From spring 2014 to summer 2017, I shared teaching duties with Asger Törnquist for a course called *Introduction to Mathematical Logic* (IML). Some of its loftier goals are, succinctly, to be able to model and analyze mathematics as a rule-governed formal system, and draw conclusions, for instance, regarding general limitations on what is or isn't provable in such a system.

Experience shows that many students (mostly bachelor students past their first year) find the course challenging; the difficulties are mostly conceptual in nature, as the technical prerequisites are relatively harmless compared to other mathematics courses.

Our intended learning outcomes are aligned, in the sense of Biggs and Tang (2011), with activities in the course as well as with assessment procedures: We require students to solve two problem sets as a mandatory home exercise which will form part of their grade. These consist of problems that

are not merely an application of the course material, or given for consolidation or drill. Instead students are asked to find proofs for theorems on further topics, with minimal preparation in lecture. This is, of course, an activity characteristic of research. As is to be expected, performance during oral exams also reflects a much deeper learning (in the sense of Biggs and Tang, 2011) from these mandatory home exercises.

Inspired by my attendance of the *University Pedagogy* course at KU, I decided to center the IML course even more on student activities characteristic of research. In the process, I was supervised by by Camilla Østerberg Rump, Institut for Naturfagens Didaktik, KU, and my postdoc adviser Asger Törnquist.

Case Study 1

One of the conceptually most difficult results taught in the one block long IML course is *Gödel's Completeness Theorem*, which could be described as stating that a mathematical statement is provable by purely logical means if and only if *any* interpretation of that statement (at least in a certain framework) is true.

I chose the following activities in connection to this theorem:

1. Students had to read a set of lecture notes (written by me for an earlier installment of IML) introducing and proving the theorem, before class,
2. Also before class, students had to take an on-line quiz (part of the intention here was to make sure each students did their reading assignment),
3. Finally, students should solve a set of problems in group work, presented to them in class. Their results were then discussed in session.

The on-line quiz was composed of short, conceptual questions, in which students were asked to use definitions from the text to draw simple conclusions. These were intended to require a deep learning approach, or in the words of Sfard (1991), to require students to construct a *mental picture* or *object* relating to the terms and concepts presented in my lecture notes, in preparation for the activities that would later be carried out in class.

The in-class problems required students to provide the some of the essential steps in the proof of the Completeness Theorem. In class, the proof of this theorem was tackled from a somewhat different viewpoint, requiring students to autonomously arrive at solutions different from the ones presented in my lecture notes. Students were therefore required to think

creatively, analyze the problem tasks, and apply terms and concepts introduced in my lecture notes in their solution.

Students were asked for some problems to collaborate with their neighbors, for others to work on their own and then to convince a neighbor of their solution (for the positive effects of peer instruction see again Mazur, 2017 and 1997). Finally, I asked them to sum up the main ideas of the proof in their own words (cf. again Törnquist, 2015).

Students carried out several activities typical of mathematical research:

- Reading and understanding a mathematical text,
- Applying definitions to analyze a problem,
- Collaborating in groups to solve a problem without being given a path to its solution,
- Explaining their solution to a colleague.

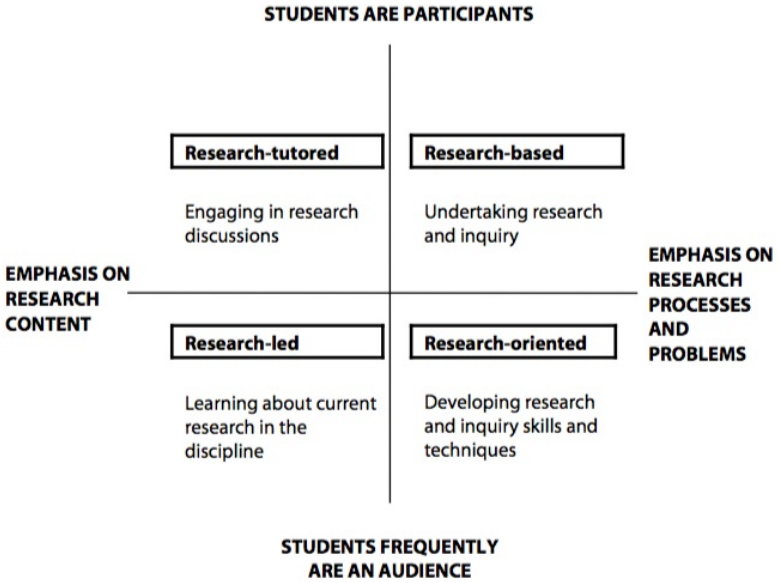

Fig. 2.1. Types of undergraduate inquiry according to Healey and Jenkins (2009), amended from Healey (2005)

According to the taxonomy in Healey and Jenkins (2009), this approach qualifies as "research based" (upper right corner in Figure 2.1) as it focuses on *research processes* and *student activity*. While students may not be performing original research in the sense of producing knowledge which is new to the scientific community, they do construct knowledge that is *new to them* using the same processes that researchers use when creating knowledge. Most significantly, this "transforms their understanding of knowledge and research" (Healey and Jenkins, 2009, p. 9).

For the most part, the experiment went extremely well: Students were very actively engaged, all but one of the problems were solved successfully by a large majority of students, and their written feedback indicates that their experience was also predominantly positive. At the oral exam, when asked about the Completeness Theorem, student answers corroborated the expectation that this approach should lead to deep learning (see Biggs and Tang, 2011, p. 21, which also contains more sources).

Case Study 2

The last part of IML introduces a particular, widely accepted way of formalizing mathematics, namely *set theory*. For this, we introduce a list of *axioms* called ZFC (for 'Zermelo-Fraenkel plus the axiom of Choice').

Students face two difficulties in this topic: Firstly, the formal way of writing axioms; secondly, a few of the axioms are hard to give intuitive meaning to, as reaching operational familiarity with them usually takes a long time.

To address just these difficulties, I took as a starting point the argument by Törnquist (2015) that speaking or writing about mathematics in ordinary, every-day language (rather than in purely technical, mathematically formalized language) helps students overcome conceptual difficulties.

For IML, I first introduced, in a 'classical' lecture style, the axioms of ZFC and an idea called the *iterative concept of set*, often used as in Boolos (1971) to 'justify' the axioms of ZFC. After that,

1. Each group chose a cluster of axioms and worked to come up with a justification of these axioms, based on the *iterative concept of set*.
2. Each group presented their findings to the rest of class.

In the process students are required to improve their 'intuitive grasp' of the ZFC axioms (again, cf. Sfard, 1991). At the same time, on a procedural

level, finding an intuitive justification for *why* something might be true, is an indispensable strategy in math research.

Finally and more concretely, students

- Collaborated to investigate a problem without having at the outset a clear a path to its solution,
- Presented their solution to their colleagues,

thus carrying out two further characteristic research activities.

This lecture in IML was extremely successful: Each group found an interesting and compelling justification of 'their' axioms (Figure 2.2, p. 7 shows a diagram drawn by a group justifying the 'Axiom of Union,' found on the top line in the figure), and student feedback was overwhelmingly positive. At the oral exam, performance regarding the ZFC axioms was better than in other years.

Reflection

I gave students several opportunities to provide oral or written feedback (handwritten, or anonymously via the learning platform) after both experiments. The majority of written feedback strongly indicates the positive effect of research related activities on student learning. Here are some of their written answers to my question "how did this lecture help you learn?":

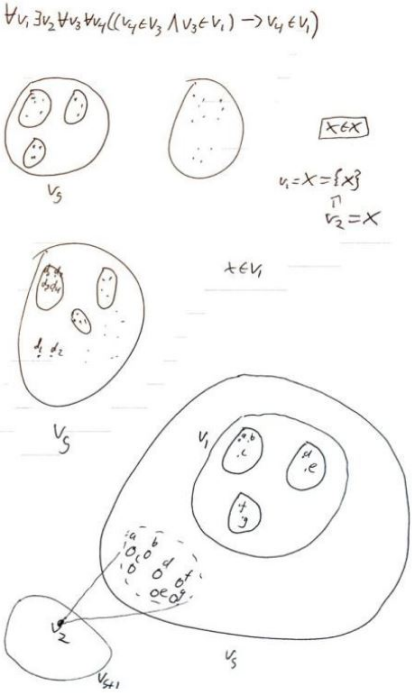

Fig. 2.2. Justifying the Union Axiom

- "It was very helpful to be 'forced' to understand each step in a complicated proof"
- "It broke with the pattern of passively listening"
- "It gives something to try and explain"
- "There is more than one way to prove things"
- "My concentration is better in group assignments"
- "[Justifying the axioms] helped me understand how you can argue from the intuitive picture"

One student indicated in their written feedback that they had further and autonomously studied a generalized version of the Completeness Theorem for uncountable languages in Enderton (2001), indicating a very deep learning approach.

On the other hand, centering student activity can put additional pressures on students. Such additional factors are the more dynamic structure of communications, as well as stress caused by competition or fear of not 'performing' as hoped – and indeed one student indicated a strong frustration with their self-perceived inability to find sufficiently many correct answers.

Understanding difficult mathematics and creatively finding solutions both take *time* and perhaps sometimes a bit of quiet, resources that become scarcer as more of students time is spent on managing the more dynamic setting of group interactions.

On a more abstract level, being unable to solve a problem *is itself a research activity* (unfortunately, a frequent one!). According to Weber (1985, pp. 524 – 55), it is part of the necessary attitude of a researcher to pursue her work at the same time with cool systematicity, a prerequisite for being open to critical dissonance, as well as to be emotionally invested in this work and driven by enthusiasm. Only both together can entice the crucial idea – but research is not churned out mechanically as in a factory, and "[i]deas occur to us when they please, not when it pleases us." This is eminently illustrates how acquiring the researcher's *habitus* is only possible through active participation.

This situation is quite opposite to that of being tested: In a graded test, being unable to solve a problem is usually not experienced as an unavoidable part of the process, but simply an undesirable end to it. And yet many a lecture that puts students activity in the center (e.g., one described in Mazur, 1997) can end up resembling a multiple choice test similar to the one used in grading, and it is perhaps easy for the student to conflate these activities – that of being tested and that of being given an opportunity to act as a researcher. This indicates that it is vital to be very clear about the distinction and frame research activities accordingly.

While many of activities which I list above are easily judged to be characteristic of carrying out research, especially in the face of the previous discussion, it seems less obvious when one is 'solving a problem without being given a clear path to its solution' and what a good problem task for such an activity might be.

The criterion I used was that the solution or the method of obtaining it could be expected to to be previously unknown to the student, as well as centrally relevant to deeper learning goals, and that the student should experience a sense of agency (rather than following some sort of recipe). Such questions can still be simple, and a more complicated problem can

easily be broken down into parts where each partial problem retains this *research-like* character. For instance, if one can expect a student to make a novel realization from following a particular algorithm, this *can* be a research problem, but such cases will be rare and I completely avoided such problem tasks in this case study.

Sometimes, problem task will in practice turn out not to meet these requirements, as indeed happened with one problem in this case study. There is necessarily an empirical element to finding problems that meet the above criteria; a repertoire of such problems must be built over time, keeping the ones that work well, and modifying the problem set if some do not.

Where Do We Go From Here

I have argued that in-class problem sessions, with the necessary preparations, are capable of allowing students to act as researchers in activities such as utilizing literature, autonomously solving a problem, collaborating, explaining, and so on. I have also argued that test-like or fast-paced formats can stand in the way of real participation in these activities.

For future implementations, I therefore suggest and intend to more often and more casually integrate such problem sessions into the lecture. Integrating problem sessions without *first* having to redesign an entire sequence of lectures (as is the case with an in-class quiz, for example) has the advantage of allowing more frequent and flexible implementation, with the same or greater positive effect on learning depth. Eventually, the course will be redesigned in its entirety through this integration.

Numerous additional activities can be suggested that integrate research or research-like activities from the later curriculum into a lecture course or the corresponding exercise class. For example, to require students to:

- Discuss or present material that has been assigned for autonomous study, such as a reading assignment
- Themselves select material for autonomous study, for example from a pre-compiled list, or to compile a bibliography
- Write short expositions of topics assigned or selected for autonomous study or based on in-class activities

An excellent way of integrating such activities into the course in a manner that aligns intended learning outcome, activities and assessment could

be a mandatory or even graded *portfolio* documenting students' research activities.

Here is one of *my own* learning outcomes from the process this paper reports on: Written student feedback as well as writing down my own reflections are an immensely useful tool for developing my teaching methods. Therefore, implementations of the above ideas should be documented using both. In this manner, results can form a basis for reflections that in turn lead to further experimentation and new implementation – teaching competence perpetually in the making.

Finally, my personal experience strongly indicates that students success in the later curriculum (especially writing a thesis) correlates very strongly to the amount and quality of participation in research activities that they have had up to that point. Therefore, it is highly desirable to increase this participation.

Designing lectures that include research activities for students is important since such a large portion of the early curriculum is currently spent in lectures; but other ways may be even more effective and should be pursued, such as seminars in which students prepare lectures, or formats in which students prepare written works autonomously.

Ultimately and optimally, this transformation process can and should be carried to the institutional level, affecting curriculum design so that research activities permeate the early as well as the late curriculum, and are required for every student.

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Part II

Student preparation

3

Evaluating the performance of strategies to get students read before class

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Introduction

Getting students to read before lecture has been proved to create good teaching-learning environment and improve students learning (Hwang & Hsu, 2011; McGinn & Schiefelbein, 2015) as it ensures students active engagement during the lecture, and help to achieve effective learning (Moravec, Williams, Aguilar-Roca, & O'Dowd, 2010). However, evidences show that non-trivial proportion of students (about 70-80 %) does not comply with the reading assignments before lecture classes (Heiner, Banet, & Wieman, 2014; Hobson, 2004). This non-compliance with pre-lecture reading is attributed to different reasons (e.g. lack of pay-off, teachers misunderstanding of the students behaviour) (Schwartz, 2014) and makes the students that do not read before lectures learn less from the lecture classes and fail to catch up with the course literature which eventually affects students' motivation to the course, understanding of the course literature and their participation and learning during lecture classes and performance in exams. This has been also a common challenge for many of the courses in our department: Department of Food and Resource Economics (Pouliot, 2018). It is therefore suggested to introduce pre-lecture activities that could motivate students to read before the lecture classes and thereby enhance students' engagement during lecture classes and improve their learning outcomes (Hwang & Hsu, 2011). Introducing pre-lecture activities (without compromising the coherence of course activities and reasonable course load) also introduce variation in the teaching-learning activities and help students to learn or experience learning independently which could cre-

ate good teaching-learning environment and improve learning (Horst & Ingerslev, 2015; Johannsen, Ulriksen, & Holmegaard, 2015). Consequently, different activities has been implemented (including pre-lecture quizzes, online discussions, offline discussions at the start of the lecture) to encourage students to read before lectures. However, we know little about the effectiveness of these activities in improving students reading habit before lecture classes.

With this background, in this study, we therefore aim to find out which activity (from two: pre-lecture quiz and online discussion) is a better way to make students to read before class through conducting experiment on bachelor students (in Agricultural Economics) reading behavior during three modules (spanning three weeks) of Development Economics course. Specifically, we asked and answered the following questions: (i) whether students read before class when there is an activity before the lecture and (ii) do students spend more time on reading before the lecture class for modules with activities before the class compared to modules without an activity before the lecture class?

Methods

The population for the study is bachelor students (54) in Agricultural Economics that participate in Development Economics course in block 4 in 2018. In the course, I was involved in teaching for two weeks in May. The experiment was undertaken during three out of the eight modules (weeks) and the students were treated with having quiz before the lecture (hereafter quiz) during the first experiment week (week 3 of the course), having online discussion with guiding questions (hereafter online discussion) during the second week of the experiment (week 4 of the course) while no activity was undertaken before the lecture class (hereafter no activity) during the third week of the experiment (week 7 of the course). The quiz was not graded while the online discussion was marked and account for about 3 % towards the final grade, but had to be completed two days after the lecture class. The lecture dates for experiments were Monday morning (May 7, 2018), Tuesday afternoon (May15, 2018) and Monday morning (June 9, 2018). The students were provided access to the reading literature of the respective module on Thursdays of the week before each module commenced so that the students have enough time to read through the reading materials. A survey questionnaire was administered both before and after the lecture

class of each experiment week (see Appendix A). The survey before the lecture class collected information regarding students reading behaviour while the surveys after the lecture class collects information regarding students learning outcomes from the lecture and its relationship whether they get prepared before the lecture class. The number of students completed each surveys vary, mainly limited to the students who attended the experiment module/week: 25 students for both the pre-lecture and post-lecture survey of the first experiment week, 31 and 16 students for the pre-lecture and post-lecture survey, respectively, of the second experiment week, 22 and 19 students for the pre-lecture and the post-lecture survey, respectively, of the third week of an experiment. The data was collected using an online data collection tool SurveyMonkey (see Appendix A, B and C for the survey links).

The generated data was analyzed using simple estimation of (i) the number (percentage) of students read before class and (ii) the mean of the number of hours the students spent on reading through the module materials the teacher provides by experiment module. Significance test (one-way ANOVA, t-test for proportion tests and Tukey multiple comparison test) were also conducted to test for statistically significant differences in the number (percentage) of students read before the class and the average number of hours that the students spend on reading before the lecture class across experiment module.

Results and discussions

Figure 3.1 displays the proportion of students read before class for the different experiment modules. The results show that the students who read and did not read for the no activity module week were about 55 % (12) and 45 % (10), respectively and these proportions were not statistically significantly different (Z-statistic=-0.4671; P-value=0.6404). During the module with the quiz, about 88 % (22) and 12 % (3) read and did not read before the lecture class, respectively while 87 % (27) and 13 % (4) of the students read and did not read, respectively, before the lecture class during the module with online discussion. The proportion of students read and did not read before the class were statistically significantly different (Z-statistic=3.0254; P-value=0.0025 and Z-statistic= 3.3051; P-value= 0.0009 for the module with the quiz and online discussion before the class, respectively) suggesting that the number of students that read before the class are significantly

larger for the modules with the quiz and online discussion before the class. With regard to the number of students who read before the class across the three experiment modules/weeks, the proportion of students who read before the class for the module with the quiz and online discussion were significantly higher than the module with no activity (Z-statistic= 2.1641; P-value= 0.0305 and Z-statistic= 2.1969; P-value= 0.0280 for the module with the quiz vs no activity and the module with online discussion vs no activity, respectively) hinting that having an online discussion and the quiz before the lecture classes help to motivate students to read before the class. The proportion of students who read before the class for modules with the quiz and online discussion activities were not statistically significantly different (Z-statistic= 0.1051; P-value= 0.9163) hinting that having an online discussion and the quiz before the lecture class are somehow equally important in motivating the students to read before the lecture classes. These results suggests that undertaking either of the activities (the quiz or online discussion) before the class were effective to motivate students to read the module literature before the lecture class which is in line with other previous findings in the literature (see e.g. (Brandt, 2014; Hwang & Hsu, 2011)). This was also evident from the students' response where 21 (91.6%) and 23 (77.8 %) of the students reported that the quiz and the online discussion before the class encouraged them to read before the lecture class. The majority of the students, 72 % (22), 46.7% (7) and 52.6% (10) thought that their learning outcome were related with whether they read before the lecture class for module 3 (experiment week 1), 4 (experiment week 2) and 8 (experiment week 3), respectively (the unexpected lower proportion during the experiment week 2 could be due to the time, the hot weather and the unsuitable room for that lecture). The students also mentioned some reasons for making them to read before the class other than the quiz and the online discussion, including to actively participate in discussions during the lecture, improve their learning, and to get an idea of the topic and interest in the topic.

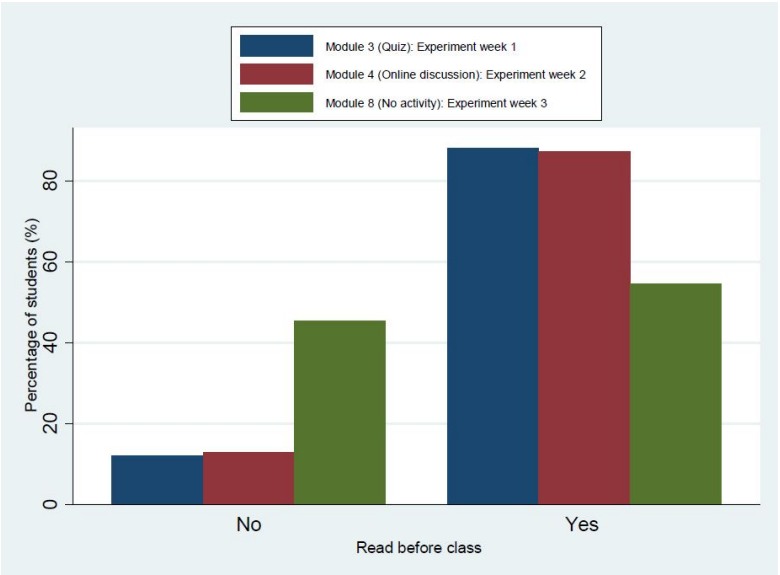

Fig. 3.1. Proportion of students read before class with no activity, quiz and online discussion before the class.

Table 3.1 presents the average number of hours the students spent on reading for each experiment week. The results show that students, on average, spent the largest number of hours in reading the course materials during the second experiment week (online discussion) (3.33 hours) followed by the second experiment week (quiz (2.35 hours) while the least during the third experiment week (no activity) (1.99 hours). These differences are statistically significant at 5% significance level according to ANOVA significance test. The Tukey multiple comparison test, only the difference between experiment week 1 and week 3 and experiment week 1 and week 2 are significantly different. This suggest that having the online discussion with marking as pre-lecture activity makes a difference in the number of hours students spent on reading the reading literature before lecture classes. With regard to the number of hours the students spent on reading a literature other than the reading literature provided by the teacher for the module, students spent largest hours during experiment week one followed by experiment week 2 and 3. The ANOVA and the Tukey multiple comparison test showed that this differences were not statistically significantly different

from each other. This means that the activities (quiz and online discussion) did not make any significance difference in students reading beyond the module materials.

Table 3.1. The average number of hours the students spent to read the course literature, other related literature and total by different activities introduced before the lecture classes; values in closed parenthesis are ranges (the minimum and the maximum values).

	Module 3 (quiz) (n=22) (1)	Module 4 (online discussion): (n=24) (2)	Module 8 (no activity): (n=12) (3)	ANOVA : F (55,2)	Tukey multiple comparison test		
					1 vs 2 (difference)	1 vs 3 (difference)	2 vs 3 (difference)
Course literature	2.35 [0.5,5]	3.33 [1,8]	1.99 [0.33,5.5]	4.11**	0.981*	0.37	1.348***
Other literature[1]	0.24 [0,2]	0.13 [0,1]	0.00 [0,0]	1.635	-0.1173	-0.2423	-0.125

[1]Any related literature the students read other than provided by the teachers; ***, ** and * significant at 1, 5 and 10 % respectively

Conclusion

This study has evaluated the impact of having activities (in the forms of quiz and online discussion) in motivating students to read before lecture classes using an experiment approach where students were treated with having quiz in the first experiment week and online discussion in the second experiment week and no activity in the third week. The findings show that the introduction of pre-lecture activities can lead to a significant increase in the number/proportion of students and the average number of hours that the students spent on the reading literature before the lecture class which is helpful to improve students learning from a particular class. Significant differences were not observed between quiz and the online discussion, in terms of the proportion of students reading before class) while the online discussion made the students to spend significantly larger preparation hours which may be due the online discussion was marked. Hence, we highly recommend lecturers to introduce simple pre-lecture activities (considering the workload of the course), preferably with marking, based on the lecture materials to make students undertake their pre-lecture reading assignments. Some limitation has however underpin this study: small and varying sample size across the experiment weeks, the study population (limited to bachelor

students and their experience during three modules of Development Economics course), two different teacher undertook the teaching during the experiment weeks might limit the generalization of the findings to other contexts. This suggests the need for further study covering different levels students, disciplines and courses and more experimental weeks.

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A

***Appendix A**: Link for the pre-lecture and post-lecture surveys for the first experiment week:* https://www.surveymonkey.com/r/BYLK6VQ *and* https://www.surveymonkey.com/r/ZWLYVV2

B

***Appendix B**: Link for the pre-lecture and post-lecture surveys for the second experiment week:* https://www.surveymonkey.com/r/KPBRDF8 and https://www.surveymonkey.com/r/K6S887X

C

***Appendix C**: Link for the pre-lecture and post-lecture surveys for the second experiment week:* https://www.surveymonkey.com/r/X7WWZGX and https://www.surveymonkey.com/r/X7XQMHB

4

Motivate student preparation with online tools and learning support

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Pre-face

It is a recurring issue in relation to teaching that students are not preparing for the classes, this has been particularly evident for me in the group teachings, where for example a scientific article has been given to the students in advance, so that it can be discussed during the course. Failure to prepare for these classes, leads in my opinion to a class discussion on a much lower level, as the teaching time will often be used to just read the article or a shallow discussion on understanding basics rather than context. It is also illustrated in previous research that students that read before classes were ready to participate extensively (Valde, 1997), and students who read before class better understand key concepts (Philips and Philips, 2007).

Previously, I have attempted to circumvent this issue by lowering my expectations on how much the students prepare, and actually giving a short introduction to the material that students were supposed to be prepared on, in the beginning of the classes. However, I don't find this to be an optimal solution, as one hands over own reflections to the student, rather than the students building their own. Therefore we started a pre-project where we wanted to know why students prepare (when they do), when are they preparing and for what type of teaching/problems/cases. The information from the pre-project is here used as inspiration for the main project, where some of the ideas will be implemented and experimented on using the knowledge obtained based on the interviews and reflections. The main outcome would be that the students feel motivated to prepare and do so.

I believe this will make the teaching more interesting for both the teacher and students.

For the pre-project we set out interviewing five BSc students, from different studies. Here there are two questions from which the inspiration for the current project and intervention study was selected: “When do you prepare?” and ”What barriers do you experience when preparing?” It was evident from the first question, that students prepare or if the preparation needs to be accounted for and to live up to someone’s expectations. This is exemplified with one citation ”If you know you are checked on your preparation, you put a little bit more effort into the preparation”. For the second question, the students particularly feel obstacles if there it too much reading and incomprehensible amount preparation material. A citation from one of the student illustrates this “If I have read 10 pages and I don’t understand the main concepts, I will close the book or “I don’t prepare if the amount of reading is too high, or when complexity is too high”. Therefore if the “teacher selects material and shows what is more interesting I prepare more”.

Conclusions from the pre-project

The conclusion on these questions were: I) prioritizing the material, so the students know what is important facilitates their preparation, so the material is not too incomprehensible, and they know they don’t have to prepare for everything equally, II) responsibility for the group, teacher or the students profession motivates preparation, therefore the setting needs to facilitate such a relation, III) students need to know the expectations regarding preparation and need to stand accountable.

Background Literature

The main theoretical source of inspiration is a study from Hoeft (Hoeft, 2012), which touches upon the three areas of interest put forward here. A recurring suggestion among the students of why they do not read is: “Maybe a little less reading at the time”, and “make it more clear what we are supposed to do”. According to Hoeft (Hoeft, 2012), illustrating what he student were supposed to do, did not increase the preparation outcome,

however, giving the students quizzes had a huge positive impact. In addition, response in a form of written response after reading has been found to ”encourage on-time reading of assignments, broader student participation, higher levels of discussion, and a more positive student experience” (Valde, 1997). Brost and Bradley (Brost & Bradley, 2006) further conclude that noncompliance, is not simply a student centred problem, and have to be addressed by faculty. They further illustrated that many of the students do not understand the pedagogical role of the assigned reading. Furthermore Kerr and Frese (Kerr & Frese, 2017) state that only 20-30 % students read the assigned reading material and that students need incentives like grades and quizzes to participate in the reading and suggest increased reading compliance if the teacher says he/she will check the reading and that student read more consistently when they understand the rationale for the reading. There are several studies illustrating the effect of quizzes. It is apparently very important that the students know that there will be a quiz if it will have motivational effect for the students (Cook & Babon, 2017) further illustrated by the work of Williams showing that random quizzes did not improve preparation (Williams, 1997). Most of the research approaches involving mandatory quizzes as a part of the final grade. However, I feel it's important that the intervention should not be about forced compliance; therefore the intervention is focus on guided compliance.

Aims

Based on the data from the pre-project and the literature the aim of the intervention study was therefore to investigate the influence of these factors on student preparation: I) Giving the student a “preparation info” to help the focus of the preparation; II) Giving the student a social commitment to prepare; III) Prepare a quiz performed in relation to preparation so the students are checked on it.

The intervention - Method

The course where the intervention took place was the *Cellular Integrative Physiology* which is a mandatory course in the specialization Cell Biology and Physiology of the MSc programme in Biology, and an elective course for the other specializations of the MSc programme in Biology and other

programmes at faculty of Science. The course is a 15 ECTS course, filling block 3 entirely and comprised of 32 students. I was giving 2 lectures of 2 hours and one interactive teaching of 2.5 hours. The main aim was to increase the preparation for the interactive teaching and use the lecture-time to increase the motivation for this preparation.

Firstly all material for the lectures (lecture slides) and interactive teaching (questions and 3 articles) was uploaded, together with a file named preparation info. Preparation info was the key element in motivating the preparation. It contained a description of what part of the material I wanted the students to look at before lecture 2, and importantly what to focus on in the 3 articles.

Intervention in lecture 1 - Friday: motivate the preparation info

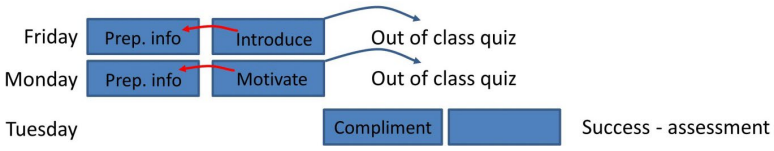
In the lecture, I told the students that I had uploaded a "preparation info" in Absalon, which would give them a focus on what to prepare for in relation to the next lecture and that there was an online quiz they could complete after reading the focus material. The motivation for the preparation was open and presented in a way that "if you want to have a look, and complete the quiz, please do".

Intervention in lecture 2 – Monday: motivate the preparation info for the interactive teaching

Out of the total 32 students, 14 people entered the Absalon page over the weekend, and 3 people completed the quiz. During the lecture 5 people answered that they had prepared by reading the suggested material. Since few people had answered the quiz, I told the student to in groups have a look at the preparation info, open the quiz, think through the questions and discuss the answers before I started the lecture. Then I told them that for tomorrow interactive teaching it is very important to me that they read the preparation material and answer the quiz. The primary outcome of this was intended to be two sided: I) All students had a look at the preparation info, II) To create a social responsibility, that it was important to me that the students did this before the interactive teaching. Finally, at the end of the lectures I presented the 3 articles using the projector, and showed them which figures and tables were important, and therefore briefly introduced them to where they should focus.

Interactive teaching – Tuesday

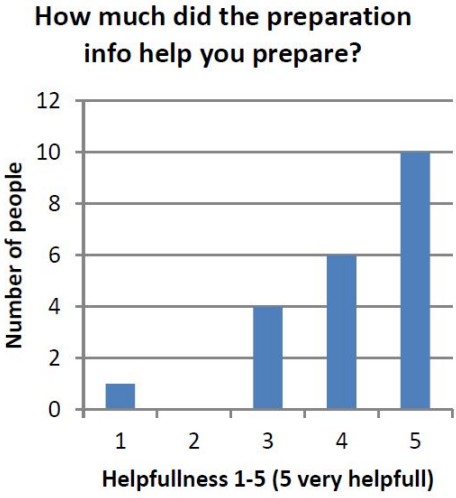
Before the interactive teaching 7(8 self-reported, one did not upload online) of the students had completed the quiz (with very good answers). There were 21 students that showed up for the interactive teaching. As the teaching commenced I asked how many had a look at the articles prior to the teaching (17 student were present at the start at 13.00, 4 students arrived later. Of the 17 students all of them had a look at the articles, and I complemented them for their preparation. Finally, I had prepared a small questioner related to the preparation to aid in concluding on the outcome and if the approach motivated them. I did not include in the form the social commitment, both rather the direct influence of the learning material "preparation info" and "quizzes".



Outcome/results

The primary outcome was the preparation for the interactive teaching, with the goal that the students had an idea of the articles in advance of the teaching. The primary outcome was met with a surprising success. Out of 21 participating students, everyone had seen the "preparation info" and 91 % had prepared for the interactive teaching (19/21). When I asked about this in the same course in 2017, only 3 out of 16 students had a look at the articles before the teaching, and in 2016 none of them had read the articles. So it is clear that the students were well prepared and although a direct correlation to the previous years cannot be drawn, there appears to be a huge increase in the amount of student preparation. Below I will look deeper into the influence of the three approaches:

I) Preparation info



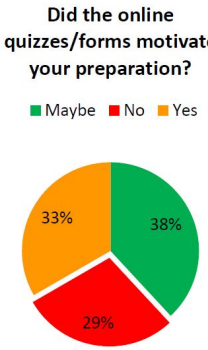
16 of 21 found the preparation info very helpful, and 20/21 told that the preparation info helped them prepare. I have selected a few citations from the comments on the preparation info:
”I think that you knew what was important made it way easier to handle the papers”.
”It gives me motivation to prepare. It also steers me in the right direction (understanding the text the right way). The info was a very good way to prepare yourself for teaching”.
“Limiting the amount we had to read in the articles was very motivating. Also this helped in order for us to understand what to focus on reading the articles. It was very useful”.

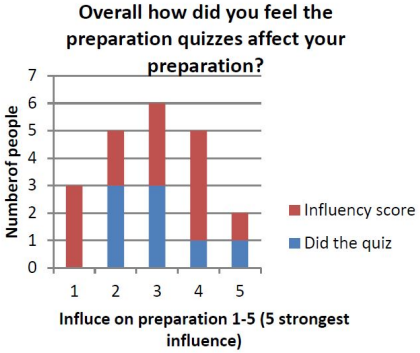
II) Social effect

For the interactive teaching, we made a social contract, where the students were asked to prepare for me so that I could use the quizzes for my teaching and that it was important to me that they did what was written in the preparation info. For the interactive teaching, out of 21 participating students,

everyone had seen the "preparation info" and 91 % had prepared for the interactive teaching (19/21). This is in contrast to the lecture where only 8 of 21 prepared at all. One factor that limits the conclusion is the case that the lecture was on Monday whereas the interactive teaching was on a Tuesday, and some of this effect could be attributed to a "weekend" effect. Nevertheless, I believe both showing the students how to prepare and give them a sense of importance increased their preparation, although I did not quantify or ask the students. Finally, the learning support, and me showing the importance in the articles could also have had an effect to increase the feeling that preparation was important.

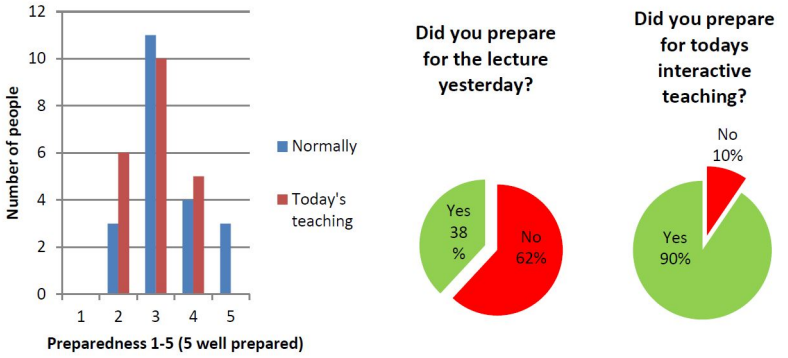
III) Online quizzes





The most interesting finding was when you dive deeper into the numbers, of the 8 people who did the quiz, only 2 were extra motivated by them. In contrast, of the 7 people who were motivated by the quizzes, only 2 completed them. This is slightly surprising, and it might appear that the threshold for handing in the answers were too high. This could maybe be improved by changing the quiz to a multiply choice rather than short answer quiz as one of the students said: "Although the questions you prepared are better and you learn more from them (when being forced to write/formulate your own answers) multiple-choice questions might also be good? So it doesn't seem like a too big a task, to find time to do both the reading and the

questions in the mind of the student" – said by **student who was motivated by the quiz, but did not complete it.**



For a limited number of students, the effect was as expected, illustrated with a quotation: "Very good. I feel a bigger pressure when there is a quiz" – said by **student who was motivated by and performed the quiz.** Although the quiz motivated the students to prepare for the teaching, there was no strong correlation between the students where they were motivated by the quiz and whether they performed the quiz. According to the questioner, the students did not prepare more for the interactive teaching compared to their self-reported level of normal preparation. This stands in strong contrast to the comparison to the previous years. Therefore it appears that the student might not have prepared more, but they time spent preparing was more beneficial for the teaching since it was more focused. In contrast to the above graph, only 8 students prepared for the lecture on Monday whereas 19 students prepared for the interactive teaching. Although some of this difference could be attributed to the difference in the two ways of teaching, there appeared to be a strong increase in preparing compared to the lecture. The preparation for the interactive teaching was much stronger, which I believe could be linked to the focus of the preparing info in lecture 2. Again the "weekend effect" might have had some influence.

Discussion

The primary outcome of the intervention was a success, and the student prepared for the teaching and they were also active during the interactive teaching. Overall the intervention model was therefore successful, however it might be difficult to pinpoint which of the three factors were the most important, but overall the main intervention that the students pointed to; was the preparation info. There were several positive comments, and this was also in line with what was expected after the pre-project interviews. Helping the students focus makes the preparation more attainable for all students, and increased the level of preparation. The implementation of quizzes have been used to motivate students in several previous studies. In contrast to the current study, most other studies have focused on mandatory and graded quizzes, many of them also with quizzes where students do not know the questions (which stimulates more in depth reading). In the study by Cook and Babon (Cook & Babon, 2017), where one of the student stated : "the quizzes were useful incentive to read the readings, and were helpful in acknowledge key themes/aspects from each reading." This stands more in contrast to students suggesting they will prepare more if they hear "I will check your reading" (Kerr & Frese, 2017).

The most interesting finding is that the quiz motivated students to prepare, but the students it motivated the most did not perform the quiz. I believe that the quiz itself was not the motivation, but that there were some specific questions, that actually helped the students focus and know what to prepare. The threshold for answering the test might have been too high. Therefore it appears that the effect of the quiz was similar to the effect of the preparation info, not that they are being held accountable for their preparation disproving one of the hypotheses. Cook and Babon (Cook & Babon, 2017) found something similar, where in their study, only 7% commented on the quizzes in relation to assessment, and they conclude that the quizzes has many functions but assessment is probably one of the least important. In conclusion, the quizzes helped the student focus, which was the main motivating effect. Going in depth of publications which rates accountability as a major factor of the success of quizzes, you can still find student answers you can find similar ideas as what is presented here. For example, students in previous studies reported regarding the effect of the quizzes: "Sometimes I just look at the quiz, and then scan the book for the concepts that relate to the questions on the quiz" (Marks, 2002) or "I find that quizzes on webCT helped me a lot to pick out the key points in each

chapter" (Marcell, 2008). Hence here the student report the uses of quizzes as a preparation info, which gives focus, rather than a check on understanding the content. Still Marks (Marks, 2002) focuses in his conclusion that the quizzes are "motivating student preparatory reading, the issue of accountability is particularly important."

Interestingly, Marks (Marks, 2002), also showed that the web based quizzes typically motivates the people who do not read in the first place. One can guess that it is also similar here as the best student will easily complete the quiz, without being motivated by it, as they have intrinsic motivation. The weaker students were motivated, but did not complete it as they do not feel as academically strong. Since many of the students did not perform the quiz, one might question whether it would have been equally successful to online upload the questions, without having the possibility to hand in the answers. However, handing in the quizzes was an important aspect of the intervention, because I) I could check how many filled the quizzes and II) I since not so many had done the quizzes, I could use that as a starting point for discussing the interactive teaching preparation in the lecture. The latter was very important because this gave the possibility to make the social contract between me and the students for the interactive teaching.

There was not a strong difference between how much the student prepared for today's interactive teaching and how much they usually prepare. However, there is a substantial difference between the two questions on how much you prepared for today's teaching, and when you ask how much you normally prepare. Response to the latter, is more likely to be affected by a social desirability bias, the replies would be more linked to how you wished you prepared, in contrast to the question, how much you actually prepared, which is much more concrete. This has been shown in other studies (Sappington, Kinsey, & Munsayac, 2002) and also commented on by Hoeft (Hoeft, 2012), where students are likely to answer what the teacher wants to hear. This could also have implications for some of the other points in this intervention. Nevertheless, the interesting finding here is the correlation between actual preparation and their reported normal preparation (which is what the student probably has as a goal). This leads me to suggest that the students prepared for the interactive teaching according to their own expectations. Some of the students who usually prepare a lot, prepared less (time), because they know new what to prepare on (focus). Therefore the students prepared more "correctly" and their preparation was had more usefulness for the teaching and the student appeared more prepared.

In conclusion, the preparation info was very useful for the students, and strongly motivated preparation. The preparation quizzes also motivated the students, but not in the way it was hypothesized. The main motivation of the quizzes, the pure existence of questions, that further helped the student focus. Nevertheless, there are a limited number of students, that are motivated by the actual test, and that they can prove their knowledge. Therefore the intervention model, with preparation info, social contract and quizzes overall improved the student preparation, because they all contributed to giving a focus so that the material appeared comprehensible.

Perspective

The outcome of this project was greatly met, and students prepared for the teaching. The students found the preparation info and quizzes very helpful to focus their preparation. This had two outcomes, I) some students spent less time preparing since there was a focus and II) almost all student prepared according their normal (wished) preparation. For the future, perspective, it would be interesting to increase not only the amount of students who are prepared but the amount of students who are well prepared. This could be to focus the preparation with a preparation info, a questions for increased focus, and then having a quiz in the beginning of the lecture, where the students did not know the answers and hence had to prepare more broadly and more likely increase the number of students being well prepared, as there now would be a competition element. In addition, it is evident that not many students did the actual online quiz, and if the teacher would like to have more feedback on whether the students understood what they prepared on, a multiple choice quiz would probably increase the response rate.

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Part III

Congruence of teaching and learning

5

Congruence in a course in Nutrition Pathophysiology

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Background

Congruence describes the interrelationships between the intended learning outcomes (ILO's) and the strategies utilized to pursue them, and can be analysed specifically from the educational perspective regarding a specific educational program. It could be assessed from a course perspective and colleague perspective as well as from the students' perspective including the students' background, competences and preconditions (Hounsell & Hounsell, 2007; Rienecker, Jørgensen, Dolin, & Ingerslev, 2015). The concept of constructive alignment embodies the specific interrelationship of a course regarded as a teaching and learning system that functions optimally when the ILO's have appropriate high quality and align with the teaching and learning activities (TLA's) and the examination (Rienecker et al., 2015).

As course responsible and teachers in a newly introduced course, we have chosen to focus mainly on the course, students' and teachers perspectives of congruence in the 7.5 ECTS mandatory MSc course in Basic Nutrition Pathophysiology (BEP) during the first year of the 120 ECTS Clinical Nutrition (CN) educational program at Science, University of Copenhagen. One of the central modules of the course is the biochemistry module since it is the key topic in the two mandatory reports and integrates elements from some of the other course modules. In this assignment we therefore have evaluated congruence in relation to;

1. The "macro-perspective": How can the course conguence be enhanced?

2. The "micro-perspective": Can the students' ILO's in biochemistry be enhanced by increased knowledge about the students' background, competences and preconditions using a common screening tool before the course start?

The course have now been running for two years, and the congruence analysis in this report will therefore be based on the experiences of the teachers and evaluations provided by the students from the first course in 2016/2017 and the second 2017/2018. Further, we will address the potential focus points for future development of the course and suggestions for improving the congruence of the course in 2018/2019.

Construct of the MSc Clinical Nutrition Educational Program

Clinical Nutrition is about how food, nutrients and nutritional supplements are used in the treatment of diseased in order to shorten the periods and reduce the severity of illness, and to improve the rehabilitation. Hence, the educational program aims on a multidisciplinary basis to educate academics in the science of human nutrition (HN) and related areas concerning the nutritional impact of optimal function and treatment during diseases. The education qualifies to a variety of occupational functions and areas e.g. treatment and counselling of diseased in the primary and secondary sector, administration and management as well as research and teaching in the industry, government agencies, and research-and educational institutions.

Yearly, a maximum of 29 students can be accepted on the CN educational program. If the number of qualified students is exceeded, applicants with a BSc in clinical dietetics have first priority before BSc's in Food Science specialised in nutrition and health followed by BSc's in Natural sciences. The applicants with a BSc in Clinical dietetics or Natural sciences must have the following courses in their BSc educational program; 7.5 ECTS in biochemistry (including exercises), physiology, statistics and pathology and/or pharmacology, while applicants from Food Sciences must have the 7.5 ECTS course in pathology and pharmacology.

In 2017 there were 49 applicants. Twenty qualified applicants were accepted into the MSc program primarily from the BSc programs in Clinical nutrition or Food Science. Most of the students came directly from their BSc educational program whereas some of student, with a background as registered clinical dietitians with years of clinical experience.

The MSc program includes 60 ECTS mandatory courses in areas such as metabolism of nutrients, dietary habits and food culture, pathology and

nutrition physiology during illness, development of nutritional and diet plans for diseased, communication and behavioural therapy, evidence criteria in clinical nutrition, and quality assurance and management (Table 5.1). Furthermore, the program comprises of 15 ECTS in voluntary courses and finally a 45 ECTS MSc thesis.

Table 5.1. MSc Clinical Nutrition Educational Program

	Period 1	Period 2	Period 3	Period 4
Year 1	Nutrition Physiology	Evidence, Diet and Health	Nutrition Physiology During Illness and Disease and Nutrition Therapy	Quality assurance and Management
	Nutrition Related Diseases	Basic Nutrition Pathophysiology		Clinical Paediatric Nutrition
Year 2	Free courses	Thesis		
	Free courses			

Analysis

Construct of the course in Basic Nutrition Pathophysiology

The educational perspectives

Due to an extensive curriculum in the two initial courses the students' experience the workload in Period 1 as high. There are however no reports to deliver in these two courses and the TLA's are mainly classical lectures. Also the workload in Period 2 is high, but with quite different TLAs, due to multiple report deliveries (two in the BEP course) and several in the parallel "Evidence diet and health" course. However, according to the educational responsible for the two MSc programs in HN and CN Professor Susanne Bügel it is impossible to reorganising the order of the courses in Period 1 and 2 in order to modify the work load for the students due to the educational construct of the parallel HN program. The educational congruence will therefore not be discussed further in this report.

The course perspectives

The first BEP course located in Period 2, was held in 2016, with the perspectives to introduce the CN students to the thinking and practices of the

CN educational program, and to reduce the students' knowledge gap earlier experienced by the teachers, in the subjects organ and immune function, and the absorption, metabolism and excretion of nutrients, between the initial mandatory courses in Nutrition Physiology (7.5 ECTS) and Nutrition Related Diseases (7.5 ECTS) in Period 1 (Table 5.1), and the subsequent 15 ECTS CN course in Nutrition Physiology during Illness and Disease in Period 3.

The ILO's of the Period 1 course in Nutrition Physiology are e.g. that the students in detail should be able to reflect, describe and discuss the digestion, absorption, and metabolism of nutrients under normal physiological functions. The ILO's of the course in Nutrition Related Diseases are that the students should be able to describe the pathogenesis of the most important life style related diseases (i.e. the metabolic syndrome, type 2 diabetes and cardiovascular diseases), and describe the effects of life style on prevention and treatment of these diseases.

The subjects taught in BEP include absorption physiology, biochemistry, metabolism, immunology, and organ function, and the current ILO's are that the students should be able to:

Knowledge

1) Describe the absorption and metabolism of nutrients in the healthy body.
2) Describe the influences of pathological processes on organ function and the metabolism of nutrients.
3) Describe the immune system and explain the central immunological mechanisms during infections and apoptosis.

Skills

4) Communicate the basic features in cell functions and interactions with organ systems.
5) Describe and discuss disease related nutritional problems with peers and other health personal.

Competences

6) Integrated knowledge concerning the cell functions, the interaction between organ systems and disease related changes in organ functions in order to analyse and discuss nutritional consequences.

The teachers' perspectives

Some of the challenges while planning the BEP course are to balance the curriculum and aims in nutrition physiology between the "healthy, normal" and "pathological" state in order to fulfil all ILO's. Furthermore, to ensure a proper academic level, and to prevent too many repetitions from the earlier courses in Period 1 (Table 5.1) and at the same time prevent overlap with the subsequent course in Nutrition Physiology during Illness and Disease in Period 3 (Table 5.1), - aspects crucial for maintaining the students' learning motivation. It is therefore important for the course responsible of the BEP course to provide colleagues and invited teachers with sufficient information regarding the course objectives, the specific ILO's for the lecture and the students' background and knowledge, and to be the consistent teacher aligning the different modules with the report writing in order to prevent some of the course congruence challenges.

Biochemistry is one of the central and underlying teaching elements of the course. This subject is taught early on in the course, and combined with lectures in the different physiological systems, the students should gain an overview over; absorption, metabolism, transport, and excretion of the macronutrient components. The BEP course is, as earlier described, the first time that CN student have a specialized course directed solely at their educational program, and it is the first time that we, as teachers, stand in front of this student group. Although a 7.5 ECTS course in biochemistry is mandatory, the students within the program originate from diverse educational backgrounds and have varied professional experience, and therefore the level of biochemistry knowledge are varied.

The students' perspectives

The students in the CN educational program are few compared to those in the parallel HN program and the BEP course is the first course that the CN students' have on their own. The students' teaching environment therefore radically changes for the students coming from large anonymous classical lectures together with all HN students in Period 1 to an intimate and interacting- and thereby potentially more individually demanding teaching environment in the BEP course.

The course in Basic Nutrition Pathophysiology 2016/2017

The first BEP course in 2016 comprised of 10 two to four-hour sessions with mixed TLA's including lectures and within lecture group work, four discussion and compilation lectures together with the course responsible to improve course constructive alignment, and finally one in basic statistics together with the HN students (Appendix A). The students received a three hour lecture in biochemistry using a mix of TLA's including standard lectures and a small group assignment. The elements of the course were planned to appear in an order that would support the students in the parallel process of group-report writing e.g. the lectures in gastrointestinal and liver function and biochemistry were given during the first part of the course when the students were writing the first group-report concerning digestion, absorption and metabolism.

Further, the students had scheduled time to work on the two mandatory group-reports during the course. The subjects of the two group reports included an in depth description of the digestion, absorption, transport, metabolism and excretion of one macronutrient in the healthy normal state derived from a specific food component (carbohydrate, fat or protein), and potential changes due to a chosen disease. Report 1 included digestion, absorption and transport of the specific nutrient, whereas report 2 focused on metabolism and excretion including a brief description of the changes due the chosen pathology.

The examination assessment comprised of the writing- and approval of the two group-reports followed by a 30 minute oral examination starting with a 20 minute group-presentation of the two reports, and a 10 minute individual oral examination without aids assessed from the 7-level scale by two internal examiners. The individual examination typically comprised of two to three questions (including a relevant illustration) in regard to central physiological aspects related to the written report e.g. 1) describe the exogenous/endogenous transport of fatty acids including Apo lipoproteins,

enzymes and receptors involved, and 2) describe the transportation and excretion of CO2 from the cell to the lungs.

Evaluation 2016/2017

The evaluation is based on the feedback from students, teachers and the course responsible. The most relevant aspects of the online student evaluations are highlighted in Table 5.2.

Course perspectives

The lecture in cell biology was unnecessary since the student's had received a similar lecture with a higher academic level in one of the courses in Period 1. The lecture regarding kidney function was given to late in the course and did therefore not support the students at the proper time during the report writing. There was too much overlap in some of the lectures from the courses in Period 1. Besides cell biology the basics in immunology had already been included in the course of "Nutrition related diseases".

Teachers' perspectives

There was too much overlap in some of the lectures from the courses in Period 1. Besides cell biology the basics in immunology had already been included in the course of "Nutrition related diseases". The teachers' experiences from the first year were that the academic level in biochemistry was highly variable and to a large degree insufficient among the students.

Students' perspectives

In general the students´ feedback were positive. The students' initial academic level in biochemistry was highly variable and to a large degree insufficient. On that background both students' and the teacher pointed out the need for more lectures in biochemistry. In parallel, the possibility for participating in the whole statistical introduction course with the HN students was raised by the students (1 week instead of a three hour lecture). In general the students found the compilation lectures useful for aligning the different modules and providing them with the possibility for repetition and clarification. Furthermore, students wanted to include peer-reviewing of the reports in order to learn the metabolism of other nutrients than the one chosen in their own report. Finally, some of the students wanted the

exam to include questions in regard to the whole curriculum and not just the objectives of the reports.

Pedagogical conclusions and perspectives of the BEP course, 2016/2017

Exchange the cell biology lectures and the discussion and compilation lectures with more time for biochemistry, statistical week and peer-review of the reports. Focus on students' prior knowledge in the subject biochemistry.

Table 5.2. Course Development and Former Evaluations

Evaluation theme	Comments, course 2017	Comments, course 2018
Student's perspectives	Better information in regard to the formal demands to the two reports Examination in the whole curriculum and not only in the reports One report instead of two and counting 40% combined with an oral exam in the whole curriculum counting 60%	Self-made groups or better planning of the groups Team work was challenging Too much time used on report presentation and peer feed
Educational perspectives	Instead of Nutrition physiology in Period 1. Structure it better with other courses. Many repetitions from the last course. Many assignments also in the parallel course so no time to read.	Team work in two different courses making it difficult to structure the time
Course perspectives	One report instead of two Group-opponents Remove the pathogenesis from the reports and ILOs and save to Period 3. More small exercises to comprehend the different subjects better (besides metabolism). The specific lectures should be planned in regard to the reports e.g. kidneys parallel with report 2 (excretion) Split the lectures to avoid 6 h in the same subject	The feedback from the other groups was too close to the submission. Some TLAs during lectures in physiological systems were missing a "nutrition angle". The literature was too basic for some subjects.

The course in Basic Nutrition Pathophysiology 2017/2018

In the course 2017/2018, the modified BEP course comprised of 14 two to four-hour lectures with a mix of TLA's including lectures and within lecture group work, and two discussion and peer-review lectures (Appendix A). The lecture in cell biology and the compilation lectures were exchanged with more time for biochemistry, a statistical week and peer-review of the reports. The following changes were included:

a. The first week of the BEP course the student's participated in a basic statistical course together with the HN students.
b. The students received six hours lectures in biochemistry using a mix of TLA's including standard lectures and a small group assignment, and further awareness about the student's prior knowledge within the subject biochemistry was sought to further increase the alignment between student's prior knowledge and the course ILOs. Further, the aim was to facilitate this by congruence between the ILOs, the teacher's awareness about the student's prior knowledge and the TLAs. This was done by applying an online pre-test to analyze student's strong and weak points and to specifically identify knowledge gaps (see appendix A). This new screening tool gave the teacher the opportunity to "choose battles". Meaning, that the TLAs were directed towards the most key element and knowledge gaps of the biochemistry subject which gave students a better opportunity to go deeper instead of broader into specific subjects. Based on experience from the course in 2017, where student focused their written assignments on protein and fat, lectures were also focused much more on carbohydrate metabolism and the most central pathways, which "bind" biochemistry together, leaving the in-depth information on fat and protein metabolism for the students to obtain during the written course work.
c. The section about pathological changes during the process of absorption, metabolism and excretion of macronutrients were removed from the group-reports. The reason was to support the students in focusing on the specific details in absorption, metabolism and excretion in the healthy organism. Furthermore, to prevent overlap with the report regarding absorption and metabolism focusing on pathology that the students will be asked to write in the subsequent course in Period 3 (Table 5.1).
d. Peer-reviewing of the two reports were included to give the students the possibility to learn about the metabolism of another macronutrients

than what they had chosen for their own report, but also in order to increase their more informal learning outcomes and skillset with elements such as scientific report writing and oral feedback.

e. The examination assessment comprised of the writing- and approval of the two group-reports followed by a 20 minute group-presentation of the reports, and a 10 minute individual oral examination without aids assessed by the same two internal examiners. The individual oral examination comprised of two questions – the same to all students within the same theme of the reports e.g. protein in regard to a central physiological aspect related to the reports.

Evaluation 2017/2018

The evaluation is based on the feedback from students, teachers and the course responsible. The most relevant highlights from the online student evaluations are presented in Table 5.2.

Course perspectives

The first week of the BEP course 2017/2018 was comprised of statistical lectures together with the HN students entailing a very brief course and reduced time for the initial group-work. The extra lectures in cell biology worked well as did advancing the lectures concerning respiration and kidney function in the second part of the course when the students were writing the group report focusing on excretion.

The TLA's included in the course to further support the students in the preparation for the exam (besides the lectures and writing of the group report) was a plenum group-presentations of the two reports, and providing peer-feedback to another groups reports. These elements gave the students the opportunity to practice the ability to discuss and to integrated knowledge concerning the various subjects from the course such as cell functions, metabolism and the interaction between organ systems.

Some of the teachers and students were displeased with the educational material, and that obtaining supplementary material was necessary in some subjects and especially in the group reports.

Teachers' perspectives

This year, an online pre-lecture test was applied before the lectures in biochemistry. In theory, this gave the teacher a "starting point" for the lectures;

however, in practice this worked both positively both also comprised some challenges. The test showed, as expected from the course year 2016/2017, that student's prior knowledge of the subject was diverse, and that a common "starting point" was quite difficult to identify. The pre-test also worked during the lectures as a "knowledge check-list", and was repeated after the 6 hours lectures in order to visualize for the students the expected minimum knowledge level.

According to the course responsible for the subsequent course "Nutrition Physiology during Illness and Disease" in Period 3 the perspective of the BEP course to prepare the students and reduce the students' knowledge gap has not been fully successful in regard to the level of physiological comprehension. A re-ordering of the themes starting with the major physiological areas such as blood circulation, and re-introduction of the discussion and compilation lectures were suggested for aligning the different modules and providing the students with the possibility for repetition and clarification.

A revision and more narrow and specific set of ILOs will improve the teachers' possibility to include more relevant TLAs.

Students' perspectives

The students' feedback of the initial week of basic statistics varied depending on the different BSc background. Most of the students' found the lectures helpful and needed while some of the students with BSc in food science thought the lectures were too basic and some of the students with BSc in clinical nutrition thought the academic level and pace were too high.

The students' feedback on the 6 hours of biochemistry was positive and gave them the opportunity to go in-depth with the most central pathways, and providing them with a solid ground for the group reports.

The congruence of feedback and assessment were good in terms of the ILO's 1, 4 and 6 (partly) since they were included and assessed during the group-report writing in terms of peer feedback during the oral presentation and group-opponent exercise. Also the oral exam was again mainly focusing on assessing the same ILO's. There were however a minimum of feedback and assessment focusing on the ILO's 2, 3 and 5, although they were included in the lectures to some degree as preparing students to the following course in Period 3 (Table 5.1). It is therefore understandable, that some of the student's again this year objected to primarily being evaluated only in certain aspects of the ILOs. Furthermore, the students asked for on-

line access to questions in order to prepare for the oral exam. This year, the assessment scheme was presented in the course description and orally to the students in the beginning and the end of the course, in order to give them a better understanding of the assessment format. The peer-feedback of the reports worked well and was well accepted by the students.

The students pointed at some disharmony in the group formation and pointed towards either making "self-made groups" or more strategic planning of the groups as strategies to improve this point. This has been discussed as an additional focus point for the course year 2018/2019, where we suggest basing group formation on different educational backgrounds, professional experience and specific competences within different subjects.

Pedagogical conclusions and perspectives

Based on the evaluation from the students in the BEP course 2017/2018 and experiences by the teachers and course responsible, some further modifications have been discussed. These include:

a. Reformulation of the ILOs (will be implemented for the course 2018/2019)

   We suggest modifying the ILO's in order to avoid overlap and distinguish between the BEP course and the course in Nutrition Physiology During Illness and Disease and Nutrition Therapy in period 3. Furthermore, to narrow and specify the ILO's to better reflect the actual learning focus and outcome of the course and thereby enhance the course, students, and teachers impression of constructive alignment.
   The modified ILO's are as follows:

   Knowledge

   1) Describe and explain the absorption, metabolism and excretion of macronutrients in the healthy body.
   2) Describe organ functions in relation to absorption, metabolism and excretion of nutrients.
   3) Describe cell, organ and immune functions and mechanisms of cell death in the healthy body and relate to basic pathological processes.

   Skills

4) Communicate, describe and discuss cell, organ and immune functions and mechanisms of cell death in the healthy body with peers and other health personal and relate to basic pathological processes.
5) Communicate and discuss absorption, metabolism and excretion of macronutrients through cells and organ systems with peers and other health personal.

Competences

6) Integrated knowledge concerning the cell, organ and immune functions in order to analyze and discuss macronutrient metabolism in the healthy body and relate to basic pathological processes.
7) Integrated knowledge concerning the regulation and effects of supply of blood and oxygen on cell, organ and immune functions.

b. The week course in statistics was cancelled by NEXS, Frederiksberg Campus educational board, and therefore 12 lectures were "returned" to the BEP course providing more time for introduction, group formation and group work.
c. The individual oral exam will besides the questions related to the reports also include one question on the course curriculum.
d. The text book in Medical Physiology will be exchanged in the course 2018/2019 with the same one used in Period 3. Further, the relevance and necessity of including supplementary materials for example during report writing will be highlighted verbally and in writing during the course to make the students aware of their responsibility to perform relevant literature search.
e. The themes will be re-organized starting with the major physiological areas. The course responsible will give a brief oral feedback of the first report, and only one group presentation and peer-review session of the reports will be included. Discussion and compilation lectures have been re-introduced to improve course alignment and the students' understanding (Appendix A).
f. The biochemistry "pre-test" used 2017/2018 to evaluate the students' pre-requisitions will be combined with a guideline for the basic academic entry level supplemented and relevant YouTube videos (Appendix C) to provide the students the ability to pick up lacking knowledge. Furthermore, an on-line study questionnaire will be developed in all modules to match the students' and teachers' academic expecta-

tions, and to provide the students' with subject specific study questions to be used before and after lectures as well as for repetition before the oral exam (see example Appendix D).

Appendixes

A Lecture plans for 2016/2017, 2017/2018 and 2018/2019.

B-C The biochemistry questionnaire used in 2017/2018, and the suggested changes in the course 2018/2019.

D On-line questions to specific modules.

References

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A

Appendix 1 Course plan 2016-2017, 2017-2018 and 2018-2019

	2016-2017	2017-2018		2018-2019	
	Theme				
	Kursus introduction				
1	**Basal cellebiologi** At den studerende kan beskrive opbygning og funktion af celler, samt basale cellebiologiske processer herunder transportmekanismer	1-20	**Statistik**	1-4	**Kursus introduktion,** gruppedannelse, introduktion til Temaopgave 1 og 2 samt mundtlig fremlæggelse og gruppe-opponering.
2-3	**Basal cellebiologi** At den studerende kan beskrive opbygning og funktion af celler, samt basale cellebiologiske processer herunder transportmekanismer			5-8	**Respirationsfysiologi** At den studerende kan beskrive respirationsfysiologien i den raske organisme, samt hvordan lungefunktion påvirker metabolismen af næringsstoffer.
4	**Gruppedannelse og introduktion til temaopgave 1**			9-12	**Gruppearbejde**
5-6	**Absorptionsfysiologi** At den studerende kan beskrive og relatere digestion og absorption af næringsstoffer og metabolismen heraf i den raske organisme			13-20	**Hjerte/kredsløb fortsat** At den studerende kan forstå og redgøre for hvordan hjerte-kredsløbet sikrer transport af næringsstoffer og metabole affaldsprodukter til og fra celler.
7-10	**General introduction to statistical analysis** At den studerende kan forstå teorien bag og anvendelsesområdet for de grundlæggende statistiske analyser			21-24	**Gruppearbejde**
11-12	**Immunologi** At den studerende kan forstå og beskrive immunforsvarets opbygning og funktion			25-28	**Absorptionsfysiologi** At den studerende kan beskrive og relatere digestion og absorption af

					næringsstoffer og metabolismen i den raske organisme.
13-14	**Centrale immunologiske processer ved infektion og celledød** At den studerende kan forstå og beskrive immunforsvarets opbygning, redegøre for immunologiske mekanismer ved bl.a. infektion og celledød			29-32	**Lever, opbygning, funktion, metabolisme** At den studerende kan forstå og beskrive leverens opbygning og basale funktioner samt metabolisme.
15	Diskussion/opsamling af cellebiologi og immunologi, relation til KE			33-35	**Øvelse: Cirkulation, absorption og levermetabolisme** At den studerende kan forstå og beskrive hvordan næringsstoffer fra et måltid absorberes samt transport til og metabolisme i leveren.
16-18	**Lever, opbygning, funktion, metabolisme** At den studerende kan forstå og beskrive leverens opbygning og basale funktioner samt metabolisme			36-43	**Den intermediære metabolisme introduktion** At den studerende kan beskrive og redegøre for metabolismen af næringsstoffer i den raske organisme.
19	Diskussion/opsamling, absorptionsorganer, relation til KE			44-47	**Arbejde med temaopgave 1** **Sende temaopgave 1 (e-mail: kursusansvarlig) for feedback**
20-27	Arbejde med temaopgave 1		**Kursus introduktion, gruppedannelse og introduktion til Temaopgave 1 og 2**	48-50	**Øvelse: Cirkulation og metabolisme** At den studerende kan forstå og beskrive hvordan næringsstoffer fra et måltid absorberes, transporteres og metaboliseres i forskellige væv.
28-30	**Den intermediære metabolisme** At den studerende kan beskrive og redegøre for metabolismen af næringsstoffer i den raske	20-26	**Den intermediære metabolisme** At den studerende kan beskrive og redegøre for metabolismen af næringsstoffer i den raske	51	**Feedback temaopgave 1**

	organisme		organisme		
30-36	**Hjerte/kredsløb** At den studerende kan redgøre for hjerte-kredsløbets basale opbygning og funktion, samt eksempler på hvordan sygdom kan påvirke den normale regulering	27-31	**Centrale immunologiske processer ved infektion og celledød** At den studerende kan forstå og beskrive immunforsvarets opbygning og redegøre for centrale immunologiske mekanismer ved bl.a. infektion og celledød	52-55	**Nyrerne, opbygning, funktion, metabolisme, væskeregulering** At den studerende forstå og beskrive nyrernes basale opbygning, funktion og metabolisme. At den studerende kan redegøre for de basale træk vedrørende væskeregulering.
37-40	Fremlæggelse af temaopgave 1, diskussion i plenum	32-36	**Lever, opbygning, funktion, metabolisme** At den studerende kan forstå og beskrive leverens opbygning og basale funktioner samt metabolisme	56-59	**Arbejde med temaopgave 1** **Sende temaopgave 1 (e-mail: kursusansvarlig) for feedback**
	Aflevering af temaopgave 1 (aot@nexs.ku.dk)	37-40	**Absorptionsfysiologi** At den studerende kan beskrive og relatere digestion og absorption af næringsstoffer og metabolismen heraf i den raske organisme	60-62	**Nyrerne, opbygning, funktion, metabolisme, væskeregulering** At den studerende forstå og beskrive nyrernes basale opbygning, funktion og metabolisme. At den studerende kan redegøre for de basale træk vedrørende væskeregulering.
40-42	Diskussion/opsamling af metabolisme i relation til KE	41-44	**Arbejde med temaopgave 1**	63-65	**Øvelse: Metabolisme og ekskretion** At den studerende kan forstå og beskrive hvordan næringsstoffer fra et måltid absorberes, transporteres og metaboliseres samt hvordan metabole restprodukter udskilles.
43-44	**Respirationsfysiologi** At den studerende kan beskrive respirationsfysiologien i den raske organisme, samt eksempler på hvordan sygdom kan påvirke den	45-52	**Nyrerne, opbygning, funktion, metabolisme, væskeregulering** At den studerende forstå og beskrive nyrernes basale opbygning, funktion og	66-70	**Centrale immunologiske processer ved celledød** At den studerende kan forstå og redegøre for centrale immunologiske mekanismer ved celledød.

	normale regulering		metabolisme. At den studerende kan redegøre for de basale træk vedrørende væskeregulering		
45-46	Gruppevis feedback på temaopgave 1 + introduktion til temaopgave 2	53-56	**Fremlæggelse af temaopgave 1** samt aflevering til opponentgruppe At den studerende mundtligt kan redegøre for hovedindholdet i Temaopgave 1 (15 + 5 min). At den studerende aktivt tager del af undervisningen i form af konstruktiv tilbagemelding på øvrige gruppefremlæggelser	71-74	**Gruppefremlæggelse af temaopgave 1 & 2 med feedback**
47-50	Arbejde med temaopgave 2	57-60	**Respirationsfysiologi** At den studerende kan beskrive respirationsfysiologien i den raske organisme, samt eksempler på hvordan sygdom kan påvirke den normale regulering.	75-78	**Arbejde med temaopgave 2** **Aflevering af temaopgave 1 & 2 til opponent + assisterende gruppe**
50-53	**Nyrerne, opbygning, funktion, metabolisme, væskeregulering** At den studerende kan forstå og beskrive nyrernes basale opbygning, funktion og metabolisme	61-64	**Gruppe-opponering** (20 min per gruppe) At den studerende aktivt og konstruktivt tager del af en anden gruppes Temaopgave 1 i form af mundtlig opponering.	79-82	**Gruppe-opponering** (10 min feedback fra hovedopponentgruppen + 5 fra assisterende gruppe). At den studerende aktivt og konstruktivt tager del af en anden gruppes temaopgaver i form af mundtlig opponering.
54-58	**Nyrerne, opbygning, funktion, metabolisme, væskeregulering** At den studerende forstå og beskrive nyrernes basale opbygning, funktion og metabolisme. At den studerende kan redegøre for de basale træk vedrørende væskeregulering	65-71	**Arbejde med temaopgave 1**		**Spørgetime og kursusevaluering**
59-60	Fremlæggelse temaopgave 2 med diskussion		**Aflevering temaopgave 1 (aot@nexs.ku.dk)**	83-90	**Arbejde med temaopgave 2** **Aflevering af temaopgave 2 (e-mail: kursusansvarlig)**

61-62	Arbejde med temaopgave 2	72-78	**Hjerte/kredsløb** At den studerende kan redgøre for hjerte-kredsløbets basale opbygning og funktion, samt eksempler på hvordan sygdom kan påvirke den normale regulering		
63-70	Arbejde med temaopgave 2	79-90	**Arbejde med temaopgave 2**		Eksamen (20 min gruppefremlæggelse + 10 min individuel eksamination)
	Aflevering af temaopgave 2 (aot@nexs.ku.dk) Spørgetime og kursusevaluering	91-94	**Fremlæggelse af temaopgave 2** samt aflevering til opponentgruppe At den studerende mundtligt kan redegøre for hovedindholdet i Temaopgave 2 (15 + 5 min). At den studerende aktivt tager del af undervisningen i form af konstruktiv tilbagemelding på øvrige gruppefremlæggelser.		
71	Gruppevis feedback på temaopgave 2	95-97	**Gruppe-opponering** (20 min) At den studerende aktivt og konstruktivt tager del af en anden gruppes Temaopgave 2 i form af mundtlig opponering		
	Eksamen		**Spørgetime og kursusevaluering** **Aflevering af temaopgave 2 (aot@nexs.ku.dk)**		
			Eksamen		

B

Appendix 2 Biochemistry Questionnaire (pre-test), 2017-2018

1. Hvordan bedømmer du selv dit kendskab til biokemien? (a.Intet kendskab; b. begrænset kendskab, c. Middel kendskab; d. jeg kan teorien fuldstændigt, men har begrænset praktisk viden; e. jeg er skarp både teoretisk og praktisk).
2. Beskriv dit kendskab til biokemien – og evt. tidligere kurser. Beskriv gerne evt. mangler/svagheder og styrker i din viden, så vi kan tilrettelægge undervisningen efter det. Endvidere kan du her stille specifikke spørgsmål til forelæsningen, som du gerne vil have, at vi tager fat på.
3. I hvilket kompartment i kroppen er kalium højest (a. extra-cellulært; b. intracellulært; c. Der er ligevægt mellem de forskellige kompartments).
4. Hvad er pH i det raske individ (a. pH 7.35-7.45; pH 7.75-7.80; pH 6.05-6-15).
5. Hvilke ”pumper” er med til at opretholde membranpotentialet i kroppen (a. Calcium-pumpen; b. adrenalin-pumpen, c. Na/K-pumpen).
6. Hvilket molekyle er det mest energirige i kroppen? Og hvor mange phosphatgrupper indeholder det? (a. ATP, 3 phosphatgrupper; b. ATP, 2 phosphatgrupper; c. ADP, 2 phosphatgrupper).
7. Hvad er forskellen på en co-faktor og et co-enzym? (a. Co-faktorer er organiske/in-organiske dele af enzymet (eks. Hæmoglobin, myoglobin etc.). Co-ezymer er organiske, ikke permanent bundne ”bærere” (eks. Jern, zink); b. Co-faktorer er organiske/in-organiske dele af enzymet (eks. Specifikke aminosyrebestemte bindingssites). Co-ezymer er organiske, ikke permanent bundne ”bærere” (eks. Jern/zink); c. Co-faktorer er organiske/inorganiske dele af enzymet (eks. Jern og zink). Co-enzymer, er organiske, ikke permanent bundne ”bærere” (eks. NAD+)
8. Indsæt de manglende ord i den nedenstående tekst: Hydrogen/elektronbærere (/) afgiver som driver en pumpe, der pumper hydrogen ioner over den indre membran. Dette resulterer i en proton-gradient, der driver via ”lollipop”-princippet til at omdanne til . (a. NADH/FADH, elektroner, mitochondria, ATP-synthasen, ADP til ATP; b. ATP/ADP, protoner, mito-

chondria, ATP-synthasen, NADH til FADH; c. NADH/FADH, kalium, mitochondria, natrium/kalium-pumpen, ADP til ATP).

9. Hvad er den primære "lager-form" for glucose? (a. Fedt; b. Glycogen, c. glucose).
10. Kan fedt omdannes til glucose? Og hvis ja, hvordan (beskriv)? (a. Ja, omdannelsen er reversibel, b. Nej, ensymet der omdanner pyruvat til acetyl-CoA er ikke reversibelt, c. Nej, ikke direkte, fedt omdannes via Krebs cyklus til glucose).
11. Hvilke er de 3 hoved-pathways, der er involveret i omdannelse af glucose til energi? (a. glycolysen, krebs cycklus, oxidativ phosphorylering; b. Glyconeogenesen, oxidativ phosphorylering og respirationskæden; c. Glycolysen, Krebs cyklus, respirationskæden).
12. Glykogenlageret i musklerne er større end i leveren. Bidrager muskelglycogen depoterne tilsvarende til opretholdelse af blodsukkeret? (a. Ja, begge depoter bidrager lige meget; b. Nej, leveren er det primære organ i forhold til blodsukker-regulering. Glykogendepoterne i muskulaturen bruges primært i forbindelse med fysisk aktivitet; c. Depoterne i musklerne bidrager mere til opretholdelse af blodglucose, da de er direkte relateret til musklernes metabolisme i forbindelse med fysisk aktivitet).
13. Hvilket enzym er ansvarlig for at splitte et C-6 molekyle til 2 C-3 molekyler i glykolysen (a. aldolase; b. Triose-phosphat-isomerase; c. phosphorfructokinase-1).
14. Fruktose indgår også i glucolysen. Hvorfor afviger metabolismen af dette molekyle fra glykose? (a. Fruktose omdannelsen er "billigere" end glucose; b. Fruktose indgår efter pkt. 3 i glycolysen og springer derfor de to første ATP-krævende trin over; c. Fruktose metabolismen er modsat glukose metabolismen ikke en reversibel proces).
15. Hvor meget ATP dannes der ud fra 1 mol glukose i glykolysen (a. 4 ATP (2 NADPH); b. 2 ATP (2 NADPH); c. 2 ATP (4 NADPH).
16. I hvilket væv er pentose-phosphat pathwayen vigtig? (a. Fedtvæv og røde blodlegemer; b. Fedtvæv og hjernen; c. fedtvæv og hjertemuskulaturen).
17. Hvor finder Krebs-cyklus sted (a. Ribosomerne; b. Cytosolen; c. mitochondria matricen på undtagelse af enzymet succinat dehydrogenase).

18. Hvad er målet med Krebs cyklus? (a. at generere energiholdige forbindelser til elektrontransportkæden, at fraspalte to c-atomer – og at regenerere oxaloacetat; b. At omdanne fruktose til oxaloacetat; c. at omdanne Acetyl-CoA til glucose).
19. Hvorfor er der forskel i ATP udbyttet på NADH genereret I cytosolen og mitochondria matricen (beskriv)?
20. Pyruvat kan omdannes videre af 4 pathways under forskellige omstændigheder. Hvilke og hvornår (beskriv)?

C

Appendix 3 Suggested changes for the lectures in biochemistry, 2018-2019

Students will prior to the lectures be made aware of the expected knowledge basic. This is done by providing them with a table (see below), which highlights the most important aspect of the intermediate biochemistry and additional source of knowledge, if they believed their knowledge to be insufficient:

You are expected, prior to arriving at the lecture in biochemistry, to be able to know/do the following:

Ability/knowledge	I believe I have the appropriate knowledge level. (Yes/no)	Supplementary knowledge Source
You should know the purpose (what is the physiological aim), the cellular location and the regulation of the following "biochemistry cycles" 1. Glycolysis 2. Gluconeogenesis 3. Krebs Cycle 4. Electron transport chain 5. Glycogen metabolism 6. Pentose phosphate pathway 7. Urea cycle/N-amino acid catabolism 8. Beta-oxidation/fatty acid synthesis 9. Oxidative phosphorylation 10. Ketogenesis 11. Triacylglycerol synthesis		Basics of metabolism https://www.youtube.com/watch?v=wQ1QGZ6gJ8w Krebs cycle/cellular respiration https://www.youtube.com/watch?v=juM2ROSLWfw Glycolysis https://www.youtube.com/watch?v=ArmlWtDnuys Regulation of glycolysis and glyconeogenesis https://www.youtube.com/watch?v=7fuLw031H-g Electron transport chain https://www.youtube.com/watch?v=mfgCcFXUZRk Oxidative phosphorylation https://www.youtube.com/watch?v=J30zpvbmw7s Pentose Phosphate Pathway https://www.youtube.com/watch?v=EP_E-7jPnNs Amino acid metabolism https://www.youtube.com/watch?v=l0V-Xmps1mE Fat and protein metabolism https://www.youtube.com/watch?v=GnXNTC3EyWg&list=PLbKSbFnKYVY0IFIZQsDo8ZfAq8oq8cgxg

You should be able to write down/draw the different intermediate steps (molecules) and the converting enzymes in the following "biochemistry cycles" (without using aids). 1. Glycolysis 2. Gluconeogenesis 3. Krebs Cycle		See overview on Absalon
You should be able to describe how the metabolic pathways of carbohydrate, fat and protein metabolism are linked and interacting.		Anabolism and catabolism https://www.youtube.com/watch?v=ST1UWnenOo0 Fat and protein metabolism https://www.youtube.com/watch?v=GnXNTC3EyWg&list=PLbKSbFnKYVY0IFIZQsDo8ZfAq8oq8cgxg Tissue specific metabolism https://www.youtube.com/watch?v=l_e1jq_I3sY
You should be able to describe and classify different types of enzymes,		Enzymes: https://www.youtube.com/watch?v=G7ZAwUdBNFE
their activities, and co-factors in the central metabolism. Further, you should know the basic principle of free energy differences in relation to spontaneous – or non-spontaneous running reactions.		&list=RDG7ZAwUdBNFE
You should and describe the basic physiological principles of cellular compartments, osmosis, pumps i.e. Na/K-pump), energy generation, and forms of energy (ATP, ADP etc.)		Osmosis https://www.youtube.com/watch?v=rCNlG_j_gSM Pumps (Na/K) https://www.youtube.com/watch?v=C_H-ONQFjpQ ATP https://www.youtube.com/watch?v=PK6HmIe2EAg

D

Appendix 4 On-line questions to specific modules, 2018-2019

1. Forklar hvordan triglycerid absorberes – fra tarm lumen til optag på den basolaterale side af enterocytten. Hvilke enzymer er involveret og hvordan reguleres disse?
2. Forklar omsætningen af fedtsyrer i enterocytten.
3. Beskriv den exogene og/eller den endogene pathway for fedtsyreomsætning.
4. Beskriv protein fordøjelse og absorption. Hvilke fordøjelsesenzymer er involveret og hvorledes reguleres disse?
5. Forklar mekanismen bag frigørelse af insulin fra pancreas.
6. Forklar hvordan henholdsvis syre- og bikarbonatproduktionen reguleres i forbindelse med fordøjelse af makronæringstoffer?
7. Beskriv absorption af triglycerier.
8. Forklar hvordan saltsyreproduktionen foregår og hvordan den styres i parietalcellerne.
9. Hvordan reguleres kroppens pH - hvilke af kroppens organer er hovedsageligt involverede og hvilke er de vigtigste buffersystemet?
10. Beskriv glukose-alanin cyklusen.

6

Heightening learning outcome and congruence in an existing MSc course

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Justification

In the fall of 2017 I was included as one of the main teachers in a 7.5 ETCS MSc course. The course had been running for quite some years, with a well-established structure, reoccurring teachers, and with mainly positive student feedback. It was my first time teaching in University of Copenhagen, and even though I had previous experience, I was reluctant to impose alterations to the existing course structure. During the course – and especially during my work on constructive alignment of the same course – I got the feeling that even thought this was already a good course, there would be ways to make the course even better.

I agreed with the two other main teachers (and course responsibles) that we would aim to make use of the constructive alignment analysis, and this final project report for Teaching and Learning in Higher Education is therefore a description of my efforts further refine, present, discuss and implement the suggestions from the aforementioned constructive alignment. However, before getting too deep into the details, I will start by describing the course in more detail.

The course

The course in question is "From plants to bioenergy". A 7.5 ETCS course that covers a quite wide span of topics from plant cell wall structure, over molecular plant breeding strategies for biomass target traits, all the way

to process enzymology. Due to the wide span of topics there is also high teacher diversity and around 10 different teachers are giving lectures.

Generally, the course is mainly taught with PowerPoint based classroom teaching. There are around 20 students attending and since it is an elective course offered on 4 different study programmes there are likewise high student diversity. In previous years close to none student were filling in the final course evaluation, but when communicating with previous students there were generally rather positive feedback.

The complete constructive alignment of the course should not be repeated here but in short, the analysis was based mainly on Hounsell and Hounsell's (Hounsell & Hounsell, 2007) description of the constructive alignment, where the concept of congruence is introduced as a broader framework. They introduced several dimensions of congruence that I included in the constructive alignment analysis. In the final recommendations I reached during the analysis, I found room for improvements in most of the six teaching-learning environments which is defined by Hounsell and Hounsell (see illustration).

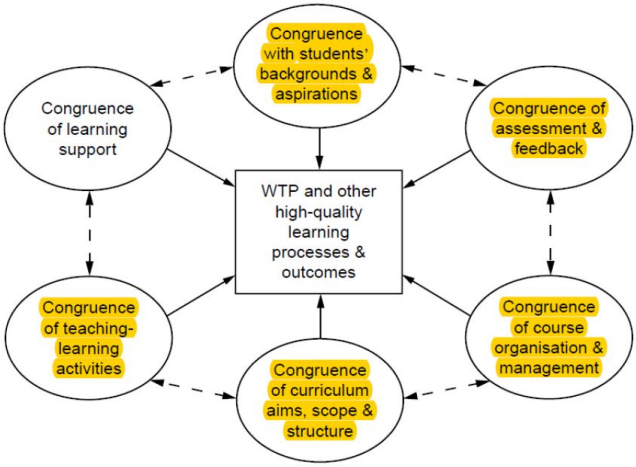

Fig. 6.1. Illustration adapted from Hounsell and Hounsell (Hounsell & Hounsell, 2007) showing the congruence between teaching and learning environments, and their impact on ways of thinking and practising (WTP) in a subject (i.e the student). The highlighted course settings were all highlighted in my analysis.

The most important findings in this analysis were the following. In relation to both the congruence of curriculum structure, course management and teaching activities, I found it beneficial to underline "the red thread" in the course to a further extent. E.g. by using the first and/or last part of each course day to talk about how the topic of the day is related to topics of past or future topics. I suggested that it should be one of the main teachers contextualising the lectures of the invited experts, as this would create a sense of congruence throughout the course and increase congruence between invited teachers and course ILOs. In line with this, I suggested to have more uniform ILOs throughout the duration of the course and to present them in a more structured way. Furthermore, I suggested that the main teacher should do a roll-call, making it possible to enforce the demand of 80% attendance which is given in the course description.

In relation to the congruence of assessment and feedback, I claimed in the analysis that the summative assessment could be optimised since we only to a limited extent were training the students what is being tested in exam, while the exam is not fully reflecting the learning outcomes we want to achieve. Therefore, I came up with two suggestions. 1) Ask all teachers to make at least one exam like questions at each course day, and provide these as voluntary homework. And 2) Include the existing poster session, which is used in the teaching, as a more important part of the summative assessment, e.g. by grading the posters and letting this grade count for 25% of the final grade.

So, on this basis, I set out investigate to which degree there is agreement between my analysis (from the constructive alignment exercise), the opinion of the previous students and the opinions of my colleagues, on how to heightening learning outcome and congruence in the *"From plants to bioenergy"* course. And further, I will describe which alterations to the course there ended up being be agreement upon within the group of main teachers. It should be noted that the narrative style of this report is successively and personal, unlike scientific writing, as this was advised by a colleague who read the draft.

Planning

At this point I had reached the conclusion that even if this were a popular course, there were room for optimisation. I had some ideas of where to make an effort from the aforementioned constructive alignment, and it

was now time to get inputs and insights from the other stakeholders. This part was divided into 3 distinct phases. 1) A planning phase where I defined a few work hypothesis on how to improve the course. 2) An interview with previous students who had just finalised the course to discuss my ideas and to get better hold on the student perspective. 3) And finally, an interview and discussion with the two other main teachers/course responsibles in which we both discussed my recommendations and planned how to introduce these changes in the course.

The planning phase

I only had the possibility to talk to a few students for a limited time, and therefore the planning should enable to get honest and constructive answers in that limited time. I chose to work with an interview guide that I divided into 5 themes. 1) The expectations of the students. 2) The students' perception of the expectations to them, which in this case relates to congruence between the exam and the skills they were taught. 3) The "red thread" during the course. 4) Ways to increase attendance. And finally, 5) congruence of reading material.

In the interview guide, the first questions within each theme were open-ended given room for honest and unexpected answers. Additionally, a few more concrete follow-up questions were defined within each theme. And in most cases I ended a theme by proposing solutions to specific problems. I had planned to interview 4 student, however, when the date and time were settled only two student were able to attend. I decided to make a group interview, aiming for a more dynamic interview with both students present. Further I planned to make a sound recording, avoiding the agony of taking notes during the interview.

The interview with previous students

Two students from two different study programmes attended the interview. Coffee, tee, and Danish pastry helped creating a friendly atmosphere. The students were happy to help and they answered my questions readily. It should be kept in mind that these were only two students and that the answers are not necessarily the voice of the majority.

Discussion with course responsibles

After the interview with students I planned a meeting with the two other main teachers/course responsibles, where I presented my conclusion based on the constructive alignment and the student interviews. The desired output of this meeting was not only theoretical inputs but actual planning. And further this planning should be learning-centred to a further extent instead of the content-centred approach that often is the outcome of course planning meeting, and which have the tendency to result in a "list of topics" rather than real learning experiences (Fink, 2003; Jørgensen, 2015).

For this meeting an interview guide was prepared as well, however this meeting also served as an actual conversation on how to arrange the course next time. Therefore, it was not a real interview but rather a structured meeting. The two other main teachers/course responsibles seemed pleased with some new inputs to a course that they had been teaching for years, and the meeting outcome were several new elements that we agreed upon. These elements and the inputs from students and teachers alike will be presented in following section.

Discussion

The interview with previous students

1) The expectations of the students (to the course). According to my analysis there were a risk that the course was too fractionated, with large student diversity and a number of different expert teachers. But at first, the student on the contrary appraised the flow of the course when moving from one topic to another. Likewise, they found the level of the course appropriate.

Since I made it clear that all ideas and inputs were welcome, the student already at this point had some recommendations. Firstly they would like a bit more research-based teaching, and especially a tour of the different laboratories of the main teachers were recommended since this can give a nice insight into the scientific process. I really liked this idea, also since it can be used as a part of the recruitment process of new MSc students. Secondly, they proposed to do several smaller reports, and present it – as a way to encourage preparation. This idea is also quite interesting to me, do to two aspects. On one hand, we do struggle to get the students to prepare which this would support, and simultaneous using small reports as a

fast written exercise can be a very nice change of media enabling another learning dimension and more variation in teaching methods.

2) The students' perception of the expectations to them. In the open-ended part of this theme, the students were a bit puzzled. I suspect that they are not used to relating to this. The more closed questions in this theme circled around the issue: *"do you feel the exam tested the skilled you were taught during the course?"*, since I found that there might be a lack of congruence. I asked them specifically if including an exam-like question in each lecture would be beneficial and they responded very positive to this idea. They mentioned that it would aid both their learning and their exam preparation.

As a part of the course there is a poster session that we use to round up the course, where the student all prepare a scientific style poster about a given topic. Until this point, attending this poster session has been a prerequisite in order to go to the exam. However, in my analysis I found that the student often do not prioritise this session. Therefore, I proposed to make the poster count as a part of the grading (e.g 25% of the final grade). The students' response to this idea was: *"That would be a good way of "getting something back", and people would make more of an effort"*. This I naturally agreed upon. Also, since we repeatedly use smaller poster sessions as a teaching methods, while we do not test those skills as a part of the exam. Thereby we will also improve the congruence between the exam and the skills taught.

3) The "red thread" during the course. Since there are many teachers and many subjects in the course I asked the students of whether they felt there was a "red thread" during the course? And generally they liked the progression and felt that overall arrangement of the topics were good. I asked specifically if any central concepts repeated to a counterproductive extent, and to my surprise they did not find that. On the contrary, the student mentioned a few cases where new teachers assumed a specific topic were already explained in previous session, where it was actually not the case. This is an obvious lack of coordination that should be addressed from now on.

We hereafter discussed options to further improve the "red thread" of the course. I suggested a more organized and uniform way of using and presenting ILO's (intended learning outcomes), e.g. as a standardized slide in the beginning of each lecture. This was seen positively upon by the two students who also suggested a summery after each topic. I ask further if the

introduction and/or rounding up should be done by a main teacher (opposed to guest lecturers), in order to secure coherence and flow during the course. This suggestion was also acknowledged by the students.

A further comment from the students was regarding the two fieldtrips in the course, where they stated that they did not always know what they were looking at. Therefore, they suggested having a more thorough presentation of the industries in the preceding lecture. They even found it beneficial to submit a short report afterwards. These suggestions are in my opinion both obvious and easy to implement.

4) Ways to increase attendance. We experienced a drop of attendance during the progression of the course, and that is even though an 80% attendance is obliged according to the course description. I learned from a colleague that a simple roll-call can help, since it will make the students feel "seen". So I asked the students how they would feel about such a roll-call. The students had another take on the matter that was quite informative to me. They felt that a roll-call is rather condescending and that no-one should feel forced to go to class. Instead they stated that *"People should go because classes are interesting and helpful – not out of obligation!"* This is a very reasonable argument in my opinion and the students even followed up with some interesting points and ideas on how to increase attendance in other ways. It is important that the students feel a gain from attending class. Therefore, there have to be difference between reading yourself and going to class, and especially going through exercises and examples are very helpful. They suggested more exercises and student presentations that students have to prepare in advance and present in class. Alternatively, the students should submit a short written report (about ½ page) after each session. These ideas were indeed interesting.

5) Congruence of reading material. Here I asked three simple questions, and the student gave likewise short answers. I asked if they bought the book, they said *"no, but they had scanned copy"*. I asked if it would have been worth the investment, they said *"no"*. And, I asked if a compendium would be preferable, they said *"yes, and it would be nice to include more scientific papers"*. These answers are in line with my own impression of the text book.

Based on the insights gained at this interview I prepared my recommendations to how to heightening learning outcome and congruence in "From

plants to bioenergy" and arranged a meeting with the main teachers/course responsibles.

Discussion with course responsibles

I started this meeting with a description of the constructive alignment, how this let me to some intermediate recommendations, and how these were refined during the meeting with the students. Overall, the course responsibles agreed to a very large extent with the diagnosis of the course, and that it was time to assess a few elements. We agreed that we have a few inherent challenges due to high teacher diversity and high topic diversity, and with that I presented my proposals condensed into three themes. Namely, "The red thread", better coherence between ILOs and the exam, and, minor changes and suggestions. In order to not repeat too many points I will rap our common conclusions in a list form (below).

1. We agreed to have a recurring intro-slide with ILOs in the beginning of each lecture, and we likewise agreed to have a slide describing how the lecture of the day relates to previous lectures. The main teachers will not do a summing up in the end guest lecturers classes (as proposed by the students) since it can undermine the authority of the guest lectures, which were an important point from a co-teacher.
2. Furthermore, we agreed to include an exam-like exercise as homework after each session. The students are expected to upload a one-slide answer prior to the following lectures, and we will choose at random who to present in the following lecture.
3. We agreed letting the poster session count towards the final grade of the exam (20%). In order to underline the importance of this session, however, it is not for certain that we can alter the exam without given permission from the study board.
4. In relation to the book, we agreed to build a compendium including chapters of books, articles, and smaller sections that we prepare ourselves. Further, we will include a small note of 10-15 lines of text describing how each piece of literature is important for the students to increase motivation (another point from a co-teacher).
5. We agreed to make a tour-de-lab of the most important laboratories.
6. We will make more of an effort to put the fieldtrip into context.

7. And finally, we agreed that we will not do a roll-call to increase attendance, but rather hope that higher quality, more exercises, and even more relevant lections will make students prioritize the course.

In my opinion, these points are all implementable and they support the ambition to make learning-centred planning creating a good learning experiences.

What is next?

The short answer is implementation by a common effort and dedicated work by all teachers involved in "From plants to bioenergy". I feel rather confident that changes will be made and that these changes will be heightening the quality, *i.e.* the learning outcome and congruence, in the course. I know for a fact that the course responsibles have already engaged in implementing some of the features.

The entirety of this process – from the start of the constructive alignment to the final common conclusions – have been an interesting learning experience to me, exemplifying one way of optimizing an existing course. Especially, it has been eye-opening how the perspectives of other stakeholders have the ability to both support and clarify my own assumptions, but also, how they can see pitfalls I did not recognize in my own eager to optimize.

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Part IV

Dialogue and case based teaching

7

Implementing mini-case to meet the intended learning outcomes

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Background

The course Sensory Evaluation of Food (7.5 ECTS) is offered by the Faculty of Science at University of Copenhagen. This course has been taught for the last 20 years but format and course title have changed several times. In 2016, the course changed to a bachelor course, and it is now compulsory for second year students doing the specialisation in "Sundhed og Ernæring" under the bachelor study programme "Fødevarer og Ernæring". Due to this, the course content and intended learning outcomes (ILOs) were adjusted.

A particular problem regarding the stated ILOs in the course description has been identified. One of the ILOs states that students achieve the skill "Ability to set up and perform basic sensory tests in a scientifically valid way". In the field of sensory science, it is of crucial importance to know and be able to perform two types of sensory tests, namely discrimination tests and descriptive tests. In the last 2 years, the course has been running, the students have got lectures in both types of tests. However, the students only had a practical exercise in discrimination tests, and thus the students did not achieve practical skills in the ability to set up and perform basic descriptive tests in a scientifically valid way. This is a major concern as descriptive test is an important tool to be able to manage for those working with sensory evaluation of food.

Aim

The aim is to develop and implement practical exercises covering the different steps in descriptive tests in order to fulfil the ILOs regarding "ability to set up and perform basic sensory tests in a scientifically valid way" and hereby improve the student's understanding of the curriculum regarding descriptive tests. These exercises should be implemented without major changes in the lecture plan and without increasing the student's work load.

Methods

Development of exercises: mini-case

A descriptive analysis is a comprehensive method consisting of several steps including: vocabulary development to describe the sensory product characteristics, training of a sensory panel in describing the products, profiling of the products using the sensory panel, data analysis and presentation of data. Due to these many steps it was decided to develop a mini-case including 4 linked exercises dealing with these steps. However the training of a sensory panel in describing the products was left out due to time restrictions. The exercises were spread out over the course and among all the exercises (in total 13 exercises in the course) such as the students worked with the exercises after they were presented with the theoretical framework.

The mini-case consisted of

- Exercise 4: Sensory vocabularies and reference standards
- Exercise 5: Profiling test
- Exercise 12: Data analysis – Own data from profiling test
- Exercise 13: Movie-presentation of sensory data

Students worked in team of approximately 6 students.

In the development of the exercises, several considerations were made regarding relevance, constructive alignment, student learning, engagement, teaching materials, teaching tools, workload and feedback.

Relevance and constructive alignment

The most important criterion for the mini-case was that it was found relevant for the course. The mini-case was created and integrated in the course

such as constructive alignment between the curriculum and student learning was obtained through relevant learning activities. Problem-based learning (PBL) was used i.e. students themselves worked with real food products and the conditions for setting up a descriptive analysis was as close as possible towards how to do in real life. Hereby, achievement of the desired learning outcomes was supported (Biggs, 2002).

It was important that the link between the different exercises resulting in the mini-case was clear to the students. The exercises were set up such as the learning from the first exercise was integrated into the next exercise etc. The overall framework of each exercise followed the theory of didactic situations (TDS) such that the students could express themselves by working independently (in teams). Example is given for Exercise 5 (Profiling test).
Devolution: The teacher presented the students for a general overview of important considerations within collecting of data using sensory descriptive analysis.
Action and formulation: The students, in teams, used their developed questionnaire from a previous exercise (exercise 1: setting up the sensory descriptive analysis) to collect data. The students prepared an actual tasting session and had fellow students from the course evaluate their food products. Hereby, the students could reflect - which is central for their learning - on issues related to both organisation of a tasting session and participation in a tasting panel.
Validation: Summing up on the exercise with the teacher. See more in the section: Formative feedback to the students.
Institutionalisation: The movie-presentation (Exercise 13) combined all the exercises and the students' presentation and discussion of methods allowed for generalisation of the topic.

Student learning and engagement

As engagement stimulates learning, the mini-case should engage the students. The student must think that the mini-case taught them something that they did not learn from the lectures and the other exercises. By having linked exercises on the same food product throughout the course, it was aimed that the student would feel a personal ownership motivating them to take responsibility in solving the exercises and consequently increase their learning.

Teaching materials and tools

The teaching materials, including the guidelines to the exercises, must be well-described. Herein, the level of instructions in the guidelines was evaluated. As this course is for second year bachelor students, it was decided that the guidelines in how to conduct the exercises should be precise and detailed but the student themselves should deal with and conclude from the results. The level of openness in the exercise can therefore be classified as level 1 according to the Table 7.1 of Tamir (Tamir, 1989).

Table 7.1. Levels of openness in teaching in the laboratory

Level	Problem	Ways and Means	Answers
0	Given	Given	Given
1	Given	Given	Open
2	Given	Open	Open
3	Open	Open	Open

Adapted from Tamir (1989)

In the end of the guidelines, a list of questions was given allowing the students to reflect upon the exercise.

In order to ensure that the guidelines were clear from a student perspective, a student assistant from last year's course proof read the guidelines.

Traditionally, the students summarise project work by preparing a written report and give an oral presentation in plenum followed by feedback from teacher and fellow students. However, this is a substantial workload for the students to do and for teachers to give feedback on. Furthermore, it is experienced that the students lose attention during the many similar plenum presentations. Consequently, a new initiative in reporting the mini-case was implemented. Each team should prepare a maximum 6 min the video-presentation of the mini-case and upload this on Absalon.

Workload

The work load for the mini-case must not be a burden to the students. They should think that the preparation for the exercise should not be too much and the time to work on the mini-case was sufficient. Work overload was tried eliminated by having the exercises integrated in the lecture plan, such as they were conducted just after the theoretical framework was presented. Hereby, the students were provided with basic knowledge for each step in

a sensory descriptive analysis instead of asking them students to apply all theory simultaneously to solve a particular problem (Tamir, 1989). Additionally, the presentation of mini-case using by video instead of written report should also reduce the workload. In order to have room for the mini-case in the lecture plan, a few exercises not working well in the previous years were taken out of the lecture plan.

Formative feedback to the students

Formative feedback is considered as an effective teaching–learning environment (Hounsell, McCune, Hounsell, & Litjens, 2008). Thus, it was important that the students got feedback from the teachers during each exercise, after each exercise and on the final presentation of the mini-case. In order to ensure sufficient feedback to the students during the exercises several teachers were available for interaction and feedback to the students. Each exercise was validated in plenum by summing up on the exercise using the questions given in the end of the exercise guidelines e.g. what was difficult? What have you learned? Reflections were shared and the teacher played an active role in discussing the issues with the students. Lastly, feedback was given to the mini-case-video presentations, partly from the students and partly from the teacher. The students were asked to provide written feedback on Absalon for minimum two teams. The teacher watched all the movie-presentations and prepared a power-point presentation to be presented in plenum with general comment and examples for different findings/statements allowing for generalisation of the mini-case. The students were told that if they wanted specific comments on the movies, they were welcome to contact the teacher afterwards.

Evaluation

Evaluation of the teaching is crucial in order to understand if improvements are needed (Ulriksen, 2014). The mini-case was formatively assessed midway by observing the students' engagement during each exercise. Oral and written summative assessments were conducted in the end of the course. The oral evaluation was held in plenum in connection to the course evaluation set up by KU. The written evaluation was set up on Absalon and covered the different aspects considered as important for studying if the mini-case had succeeded. Herein, the students rated their

agreement/disagreement in different statements for relevance, constructive alignment, student learning, engagement, teaching materials, teaching tools, workload and feedback. The written evaluation was announced on Absalon after the examination as evaluation of the relevance of mini-case in relation to the course was one of the focus areas. However, a risk of low response rate exists as the students might already focus on other activities such as new courses (Ulriksen, 2014).

Summative evaluation of the mini-case

Oral evaluation

In total, 88 students were signed up for the course. On the last course day, course evaluation was done in plenum with 64 students present (73% of the students). The course responsible and the students went through the online KU course evaluation and the students were able to give comments. Additionally, focus was given to the mini case. In Table 7.2, comments on the mini-case from the students are listed.

Table 7.2. Students evaluation of the mini-case (oral)

Overall	• the mini case was really good • keep for next year • great to get the overall picture • helps out to understand the curriculum • the time to work on the exercises was okay • deadlines okay
Leaving out an exercise about training of a sensory panel in describing the products	• panel training exercise would have been nice to have. However, it is fine the way it is as we can see the importance of panel training by not having it • learning outcome would be same if we have had the panel training
Movie presentation	• movie presentations were much better than having oral presentations in class • good to keep the feedback to 45 minutes update/sum up in class • good to have to comment on the other movies
Practical issues	• it was difficult to be a panel leader due to the noise • more rooms should be available for the exercises • as the different teams have to help each other in the evaluation of the food product, it would be nice with signs for the different teams such as the other teams are easier to find

Written evaluation

In total, 10 students out of 88 students gave written feedback on Absalon accounting for 11% of the students (see Table 7.3). This is a very low

response rate but this is expected as stated by Ulriksen (Ulriksen, 2014). However, the students' replies on Absalon should be seriously considered.

Table 7.3. Written Feedback on the mini-case from 10 students

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
In my opinion, the mini-case was relevant for the course				2	8
In my opinion, it was necessary to prepare for the exercises in the mini-case			5	4	1
In my opinion, the level of instructions in the exercise guidelines to the mini-case was good				8	2
In my opinion, I was engaged in the exercises for the mini-case				3	7
In my opinion, the link between the four exercises in the mini-case was clear			1	6	3
In my opinion, the teachers interacted well with me/the students during the exercises in the mini-case			5	3	2
In my opinion, the video-presentation instead of oral presentations in class worked good			2	1	7
In my opinion, feedback (online discussions and oral session) on the mini-case was sufficient	2	3	2	2	1
In my opinion, the time to work on the mini-case was sufficient		1	1	5	3
In my opinion, the mini-case learned me something that I did not learn from the lectures and the other exercises			1	5	4

Additional comments:

- The problem with the feedback on the movie presentation was that we got it so late in the process so you could not use the feedback properly. And also a lot of people didn't give feedback at all. Mine group didn't receive any feedback. I really like the mine case because you got to use all your knowledge that you have learned in the class. So I definitely think that you should do it again next year, just with some improvements. Maybe start the cases before in the course, so that it isn't the last thing that you do, because then all you think about and read on is the exam.
- It would have been nice to get feedback from a teacher about the video-presentation. Only 3 students gave feedback to our group and it wasn't that precisely. Since we put a lot of work into it, it would be nice to get better feedback:-)
- I´d like to have feedback for teachers and from classmates, because there were some details that would have been good to know if they were good or right on the video previous to the exam.

Discussion

The students gave very positive feedback on the implementation of the mini-case. Overall, the students found the mini-case very relevant for the course and supported their learning outcome. However, evaluation of whether the mini-case results in an improvement of the students' learning outcome with regards to descriptive test compared to previous years is very difficult.

The students were very happy about reporting their mini-case using the movie-presentation instead of writing a report. But some students found that the feedback on the movie presentations insufficient. This can be explained by students are motivated to achieve individual feedback that facilitate their own learning outcomes (Higgins, Hartley, & Skelton, 2002), especially because the exam was imminent at the same when the feedback was given. Individual feedback was not provided in terms of teacher-to-team feedback with specific comments. Instead, the teacher gave overall feedback on all the movie-presentation by presentation of general comments to the work. Additionally, specific examples from some of the movie-presentations were given to highlight points. However, students were told that if they wanted specific comments on the movies, they were welcome to contact the teacher afterwards. But, none of the students took this opportunity. Even though the students wanted to achieve feedback many of the students did not take the time to provide feedback to the other teams. To ensure more feedback from fellow students for the next year course, it will be mandatory for the students to provide feedback to fellow students in order to go to the exam. With respect to the teacher feedback, the format chosen allowed for generalisation to all students at the same time and it will be kept unchanged. However, more examples from the movie-presentation will be included such as all students find the feedback relevant for their specific work.

Some practical issues also need to be solved for next year. Complaints about the noise level in the lecture during the exercises were expressed by many of the students. One student suggested that an additional room should be available. Actually, one additional room was booked for the exercises but it needs to be more clearly informed next year. As the teams had to help each other with evaluations (profiling) of the food products, the logistics with respect to indicate who belong to which team need to be improved. This will be done by placing signs with team numbers on the tables in the class rooms.

Conclusion

Implementation of the mini-case was a success as the students showed high engagement and the mini-case helped them to better understand curriculum. However, minor adjustments regarding practical issues logistics and feedback procedure will be made for next year course.

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8

Dialog-baseret undervisning i forelæsninger om træ som materiale

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Summary. My project concerns the development of dialogue-based teaching within wood materials science for civil engineers. Teaching was done over two course dates at the Technical University of Denmark in Spring 2018 where about 50 students attended each time. Teaching was organised with two hours of lectures in a lecture hall followed by two hours of supervised classroom exercises (calculation assignments). The aim of my project was to improve the learning outcome of students by having teaching revolving around discussions rather than a monologue lecturing. This was particularly challenging as my contribution to the course involved only a small fraction of the teaching and the students were used to traditional lecturing with very little student involvement in the teaching. Thus, a specific aim at the beginning of my first teaching date was to re-negotiate the didactical contract between me and the students by signalling that I expected them to be active and participate in the discussions. While the location and the curriculum for my teaching were set, I was free to choose how I taught the curriculum. Therefore, I organised my teaching into a string of didactic loops according to the framework of the Theory of Didactic Situations. In each loop, the students were presented a minimal amount of information before they were given a question and time to reflect and discuss with their neighbour. Evaluation of the teaching method was done by the students replying anonymously to an online questionnaire with three questions: 1) Rate the connection between lectures and classroom exercises? (Score 1 to 7), 2) Did discussing with your neighbour aid your understanding of the topic? (Score from 1 to 7), 3) Any further comments? (Written answers, multiple answers possible). The students were generally satisfied with the dialogue-based teaching and they found

the teaching useful for classroom exercises based on the ratings of questions 1 and 2. However, the third question was the most useful for me in improving my teaching in the future. From my own experience in the lecture hall as well as the students' input it was clear that the re-negotiation of the didactical contract was not fully successful. As a result I will try to improve my future teaching by being more explicit in informing the students what is going to happen in the next session and why.

Indledning

Jeg har forsøgt at udvikle dialog-baseret undervisning om træ som konstruktionsmateriale i to forelæsninger til bygningsingeniører på bachelorniveau. Forsøget blev gjort i samlet fire forelæsninger fordelt over to kursusdage i foråret 2018 på kurset "11946: Materialelære, materialefysik" ved Institut for Byggeri, Danmarks Tekniske Universitet. Kurset er et grundlæggende BSc-kursus om materialers egenskaber med fokus på byggematerialer, og der var cirka 60-70 studerende tilmeldt kurset hvoraf cirka 50 mødte op til forelæsningerne. Hver af de to kursusgange bestod af to timer (inklusiv pauser) med forelæsninger i et traditionelt skrånende auditorium efterfulgt af to timers grupperegning i klasseundervisningslokaler hvor de studerende gennemregnede opgaver relateret til forelæsningernes pensum under vejleder af forelæser og hjælpelærere.

Formålet bag forsøget

Undervisning i materialelære på DTU er traditionelt foregået gennem auditorieforelæsninger hvor de studerende er mere eller mindre passive tilhørere til en gennemgang af pensum på tavlen, overhead projektor eller PowerPoint-præsentation. Eneste interaktive elementer er regneopgaver af et materiales opførsel (fx: dimensionsændringer i træ pga. fugtoptag) gennemgået på tavlen. Denne form for undervisning er så indgroet en del af universitetslivet at både studerende og undervisere forventer at undervisningen foregår på denne måde hvor de studerende aktivitet i undervisningssituationen er begrænset (Haugsted & Ingerslev, 2015). Til trods for at denne form for traditionel undervisning er en tidseffektiv måde at dække et bredt stofområde har talrige undersøgelser vist at læringsudbyttet for de studerende er lille ved passiv tilstedeværelse i undervisningssituationen (L. Rienecker

& Ingerslev, 2015). De studerende lærer simpelthen mere ved at være aktive i undervisningen (Dahl & Troelsen, 2015).

Formålet med at udvikle dialog-baseret undervisning i forelæsningerne om træ som konstruktions-materiale er at forbedre de studerendes udbytte af forelæsningerne ved at de aktivt reflekterer over og diskuterer sammenhængen mellem materialestruktur og materialeegenskaber for træmaterialer. Gennem en forståelse af sammenhængen mellem struktur og egenskaber og en forståelse af træs struktur, vil de studerende bedre kunne forstå andre egenskaber på baggrund af strukturen end de der bliver gennemgået i kurset. Derudover er målet at de studerende, gennem en forbedret forståelse af materialets struktur og egenskaber, lettere forstår baggrunden for de beregninger som udføres i den efterfølgende grupperegning, og at de derigennem vil kunne evaluere validiteten af beregnede resultater i stedet for kun at stole på at de har fulgt metoden korrekt.

Beskrivelse af forsøget

Rammerne for mit forsøg på at udvikle dialog-baseret undervisning om træ som materiale består i et fastlagt pensum i kursets lærebog samt de fysiske rammer for undervisningen, dvs. auditoriet og lokalerne for grupperegningen. Inden for disse rammer skal jeg forsøge at skabe dialog-baseret undervisning.

Genforhandling af den didaktiske kontrakt som det første

Eftersom den undervisningsform jeg har valgt til de to kursusgange bryder med formen i resten af kurset er det afgørende at der sker en genforhandling af den didaktiske kontrakt mellem mig og de studerende som det allerførste i undervisningen. Med andre ord skal jeg signalere til de studerende at min undervisning bryder med hvad de kender, og de skal ledes på sporet af hvad jeg forventer af dem ift. at være aktive i undervisningen. Som noget af det allerførste på første kursusgang havde jeg planlagt at de studerende skulle svare på spørgsmålet ”Hvad er vigtigt at vide om træ?” med deres mobiltelefon på en online tjeneste (www.Menti.com). De studerendes input blev projiceret op på lærredet i en ordsky (word cloud) i takt med at de blev indsamlet og hvor størrelsen af ordene matcher deres frekvens blandt de studerendes input. Formålet var dels at signalere at de studerendes aktive medvirken var central for undervisningen, og dels at se om de studerendes

mening om hvad der var væsentlig viden matchede mine planer for undervisningen, og evt. justere i planen for anden kursusgang.

Organisering af undervisningen

Selvom pensum er fastlagt stod det mig frit for at vælge gennemgangen af stoffet. Jeg har opbygget mig undervisning med udgangspunkt i Teorien om Didaktiske Situationer (Christiansen & Olsen, 2006). Således har jeg forsøgt at organisere gennemgangen af stoffet i små didaktiske "sløjfer" som indeholder nedenstående faser:

1. *Devolution:* Jeg præsenterer noget information for de studerende hvorefter de bliver stillet en opgave. Jeg forsøgte at præsentere mindst mulig information i denne fase.
2. *Handling:* De studerende arbejder med opgaven uden min indblanding i en kortere periode på 2-5 minutter (defineret af mig som også holder styr på tiden). Denne fase havde jeg typisk foreskrevet som "diskussion med sidepersonen".
3. *Formulering:* De studerende byder ind i plenum med deres svar på opgaven og jeg forsøger at indsamle deres input. Min tanke var at lade så mange som muligt komme til orde og derefter vekslede jeg mellem at de studerende mundtligt fortalte deres svar eller ved afstemninger på online tjenester (www.Menti.com). Formålet med at indsamle input fra så mange studerende som muligt var at belyse hele holdets forståelse af stoffet (og ikke kun de måske få som svarer mundtligt). Ved indsamling af de mundtlige svar var min plan at være opmærksom på at stille uddybende spørgsmål á la "hvad mener du med X?" eller "er det X du mener med det du siger?", således at det er de studerende faktiske forståelse af stoffet som bliver belyst og ikke deres evne til at memorere "nøgleord". Derved lægger diskussionen af stoffet sig mere op ad en "udforskende diskussion" (exploratory discussion, jf. Haugsted and Ingerslev, 2015) snarere end en "målrettet diskussion" (targeted discussion, jf. Haugsted and Ingerslev, 2015) hvor læreren åbenlyst leder diskussionen en bestemt vej, fx ved at fiske efter faglige nøgleord uden nødvendigvis at afdække de studerendes konceptuelle forståelse af stoffet.
4. *Validering:* I denne fase forsøger jeg at tydeliggøre korrekte hypoteser fra formuleringsfasen. Jeg havde derudover forberedt en række svarmuligheder på opgaverne for at sikre at centrale dele af stoffet gennemgås i undervisningen.

5. *Institutionalisering:* I denne fase leder jeg de studerende videre igennem stoffet. Normalt vil denne fase bestå i at drage paralleller fra de konkrete opgaver som de studerende har arbejdet med til generelle koncepter inden for feltet. I min undervisning er institutionaliseringsfasen i flere tilfælde en opbygning til næste didaktiske sløjfe, hvor mere avanceret information gives til de studerende og fungerer dermed de facto som en devolutionsfase.

De didaktiske sløjfer i min undervisning er centreret omkring at eksemplificere sammenhænge mellem et materiales struktur og dets egenskaber. Egenskaberne er vigtige at kunne forudsige som bygningsingeniør for korrekt anvendelse af træ såvel som andre materialer, men de væsentlige egenskaber for et materiale dækker mange forskellige fysiske fænomener. De er dog alle manifestationer af materialets underliggende struktur, hvilket er forsøgt vist i figur 8.1. I de didaktiske sløjfer i min undervisning ledes de studerende hele tiden tilbage til en diskussion af den samme materialestruktur for at forstå specifikke egenskaber ved træ. Derved repeteres træs struktur mange gange i løbet af undervisningen fra forskellige udgangspunkter, og håbet er at de studerende er i stand til at kunne forudsige omtrentlige egenskaber som ikke gennemgås i undervisningen baseret på en forståelse af materialestrukturen. I figur 8.1 er også vist eksempler på måder jeg forsøger at få de studerende til at arbejde med sammenhænge mellem struktur og egenskaber. På første kursusgang var spørgsmålene konstrueret som åbne spørgsmål af ”type 1” i figur 8.1 (fx ”Prøv at forudsige nogle af træs egenskaber ud fra kendskab til materialets struktur”), hvor de studerende på baggrund af en introduktion bedes nævne måder hvorpå strukturen manifesterer sig i specifikke egenskaber.

Fig. 8.1. Illustration af sammenhæng mellem et materiales struktur og dets egenskaber. Egenskaberne ved et materiale er alle manifestationer af materialets struktur. Antallet af forskellige egenskaber overstiger langt antallet af betydende parametre til at beskrive materialets struktur. Tallene 1 og 2 indikerer forskellige måder jeg forsøgte at arbejde med sammenhænge mellem egenskaber og struktur i mine forelæsninger: 1 = åbent spørgsmål til de studerende efter introduktion om materialestruktur. 2 = spørgsmål til de studerende efter introduktion af en egenskab/et problem.

På anden kursusgang forsøgte jeg at give de studerende spørgsmål som tog udgangspunkt i mere konkrete problemstillinger (fx "Hvordan kan vi finde ud af hvor stærkt materialet er (uden at ødelægge det)?"), hvor de skulle komme med konkrete løsningsforslag baseret på en forståelse af strukturen; i det nævnte eksempel at beskrive hvilke andre egenskaber eller strukturelle kendetegn som kan måles ikke-destruktivt og bruges til at forudsige styrken.

Evaluering af mit forsøg

Effekten af den dialog-baserede undervisning på de studerendes læringsudbytte forsøgte jeg at evaluere ved afslutningen af anden kursusgang. De studerende blev bedt om anonymt at besvare tre spørgsmål via en online tjeneste (www.Menti.com) om min undervisning. Spørgsmålene lød:

- SPØRGSMÅL 1: "Var der sammenhæng mellem forelæsning og opgaver?"

- SPØRGSMÅL 2: ”Hjalp det din forståelse af stoffet til forelæsningen at diskutere med din sideperson?”
- SPØRGSMÅL 3: ”Andre kommentarer?”

Det første spørgsmål knytter sig til de studerendes vurdering af anvendeligheden af det lærte i undervisningen ift. at gennemføre den efterfølgende grupperegning. Således forsøgte jeg at vide om den megen fokus på materialestruktur var brugbar i det efterfølgende praktiske arbejde som er fokuseret på konkrete problemstillinger. Spørgsmålet blev besvaret med en værdi fra 1 (lav/dårlig) til 7 (høj/god).

Det andet spørgsmål knytter sig til de studerendes vurdering af deres læringsudbytte ved dialog-baseret undervisning. Spørgsmålet blev besvaret med en værdi fra 1 (lav/dårlig) til 7 (høj/god).

Det tredje spørgsmål er helt åbent for at indsamle alle yderligere indtryk omkring undervisningen fra de studerende. Spørgsmålet blev besvaret med tekst og hver enkelt studerende kunne indsende så mange input som vedkommende havde lyst til.

Diskussion af resultater

Egne oplevelser af undervisningen

Første kursusgang gik ikke helt efter planen, og det var vanskeligt at få dialogen i gang med de studerende. Dette skyldtes formentlig mangler i genforhandlingen af den didaktiske kontrakt, hvor jeg ikke var eksplicit nok i mine forklaringer af hvad der skulle ske, og hvorfor tingene skulle ske på en given måde. Fx fik jeg ikke forklaret godt nok hvad meningen var med de online input og tilhørerne havde indtrykket at jeg stort set ikke benyttede deres online input i visse af de åbne diskussionsspørgsmål til noget (jf. referat fra faglig vejleder). Dette skyldtes delvist at den faglige kvalitet af de studerendes input var langt fra hvad jeg havde forventet, og derfor var det svært at få diskussionen ind på rette spor på denne baggrund.

Ved den anden undervisningsgang var jeg mindre ambitiøs med hvor meget input jeg ønskede at håndtere på een gang fra de studerende for at få dialogen i gang. Denne justering skyldtes at mængden af input fra de ca. 50 studerende ved første undervisningsgang i visse situationer var svær at håndtere for mig som underviser. Derfor var formuleringsfasen i anden kursusgang til alle spørgsmål organiseret mundtligt, således jeg kunne fokusere på eet input ad gangen. Denne fase forsøgte jeg fejlagtigt at køre uden at

skrive notater på tavlen men at huske dem i hovedet for at undgå at skrive input hulter-til-bulter på tavlen. Dette gjorde valideringsfasen svært fordi jeg skulle genkalde og strukturere de input jeg havde fået. Til gengæld var formuleringsfasen succesfuld på flere punkter. Fx lod jeg de studerende forklare deres input i dybden, og jeg accepterede således ikke input på få ord uden en nærmere forklaring. Derved kunne jeg bedre teste de studerendes konceptuelle forståelse af begreberne, og tilhørerne fik forklaret begreberne med ordene fra andre studerende. Ydermere gik jeg bevidst væk fra første række hvis de studerende på de forreste rækker kom med mundtligt input. Dette gjorde jeg bevidst for dels at opmuntre de studerende til at tale højere, og dels for at jeg mere naturligt kunne tale højt og parafrasere deres input (fx "er det X du mener?") så alle i forelæsnings-salen kunne høre det, og endvidere teste den givne studerendes forståelse.

De studerendes evaluering af undervisningen

Resultaterne af de studerendes evaluering af undervisningen kan ses detaljeret i appendiks, mens det følgende er et udpluk af de væsentligste pointer. De studerende var generelt tilfredse med læringsudbyttet af undervisningen ift. den praktiske anvendelse af stoffet til grupperegningsøvelserne (middelscore: 5 ud af 7). Ligeledes mente de studerende at diskussionerne med sidepersonen hjalp dem med at forstå stoffet (middelscore: 4.6 ud af 7). Disse resultater viser at trods fejl og mangler i udførelsen af den planlagte undervisning som beskrevet herover, var vurderingen var de studerende at læringsudbyttet ved den dialog-baserede undervisning var tilfredsstillende og samtidig praktisk anvendeligt.

De mest interessante og for mig brugbare resultater ift. at forbedre undervisningen i fremtidige kurser i materialelære er dog svarene på det tredje, åbne spørgsmål om yderligere input til undervisningen, se detaljer i appendiks. Min egen oplevelse fra første kursusgang med mindre brugbare input grundet mangler i genforhandlingen af den didaktiske kontrakt blev delvist bekræftet af de studerendes input. Som vist i appendiks under "Feedback relateret til undervisning som de studerende er vant til" efterspurgte en del studerende mere undervisning som lignede det de var vant til: flere regne-eksempler på tavlen gennemført af underviseren (jeg gennemførte kun eet traditionelt regneeksempel på tavlen i alt). De studerende var med andre ord ikke helt med på hvorfor undervisningen foregik på den måde den gjorde, hvilket grunder i mine manglende eksplicitte forklaringer af hvad der skulle ske og hvorfor. En anden årsag til de studerendes ønske

om mere traditionelle regneeksempler kan også være at disse ligner opgaverne til eksamen, og at evalueringsformen på kurset således influerer på de studerendes ønsker og forventninger til undervisningen. Jeg har forsøgt at kategorisere de studerendes input til undervisningsformen efter teorien om didaktiske situationer, se alle input i appendiks under "Feedback relateret til faser fra teorien om didaktiske situationer". Særligt handlings- og formuleringsfaserne har de studerende en del input til (se eksempler i boksen herunder), hvor visse studerende mener at der var for megen diskussion med sidepersonen og at det påvirker hastigheden hvormed undervisningen skrider frem.

Udpluk af input fra de studerende:

- "... der var lidt for mange 'opgaver med sidemanden' synes jeg :-)"
- "Lidt for meget inddragelse – man bruger meget tid på at høre på forkerte svar."
- "Godt med at stille spørgsmål ud, så vi deltager aktivt."
- "Fint at du giver god tid... Det gør at flere kommer på banen."
- "Dog giver den gode tid... at flere byder ind. Undervisningen går bare også lidt langsom."

Dette vurderer jeg skyldes en utilstrækkelig genforhandling af den didaktiske kontrakt i første kursusgang, altså at visse af de studerende ikke er klar over hvorfor de skal bruge tiden på at diskutere og høre de andres svar. Andre studerende er mere opmærksomme på at undervisningsformen og tiden til diskussioner gør at flere studerende byder ind med deres input, selvom dette begrænser den tid jeg som underviser docerer. Disse studerende har derfor ligeledes heller ikke helt forstået min rolle som underviser i dialog-baseret undervisning, igen et eksempel på at jeg ikke har været eksplicit nok i hvad der skulle foregå og hvorfor.

Ideer til forbedringer

Generelt vil jeg arbejde på at være mere eksplicit at forklare de studerende hvad der skal ske i undervisningen (min rolle, mine forventninger til de studerende) og hvorfor. Dette skal forbedre de studerendes forståelse af meningen med de aktiviteter som foregår i undervisningssituationer, særligt i tilfældet hvor min undervisning bryder med de traditionelle undervisningsformer som de studerende kender og er trygge ved. Disse forklaringer

skal ikke redegøre for teorier fra didaktik, men skal helt lavpraktisk informere de studerende om hvad der skal ske og hvorfor, fx ”nu gør jeg X fordi vi derefter skal gøre Y”. Et eksempel er min manglende brug af tavlen i formuleringsfasen grundet frygt for uordenlige tavlenotater. Fremover vil jeg derfor forklare de studerende at nu bruger jeg tavlen som hukommelse for deres input, men at jeg ikke skriver i en bestemt orden (hvis det er det jeg gør). Dette vil jeg forsøge at gøre på fx halvdelen af tavlen, og efterfølgende anvende resten af tavlen på at strukturere input og fremhæve hovedbudskaber og vigtige pointer. Herved bliver valideringsfasen mere visuel for de studerende og lettere at gennemføre for mig som underviser.

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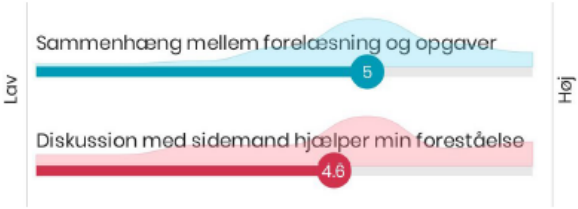
A

FEEDBACK FRA STUDERENDE TIL EVALUERING AF UNDERVISNINGEN
(Fra afslutningen på anden kursusgang)

SPØRGSMÅL 1: "Var der sammenhæng mellem forelæsning og opgaver?"
SPØRGSMÅL 2: "Hjalp det din forståelse af stoffet til forelæsningen at diskutere med din sideperson?"



(Kommentar: Skala går fra 1 (lav/dårlig) til 7 (høj/god) og middelscore er beregnet ud fra 45 besvarelser)

SPØRGSMÅL 3: "Andre kommentarer?" (Vigtige pointer fremhævet af mig med gult)

1) Feedback relateret til undervisning som de studerende er vant til
"Jeg kunne godt tænke mig at du sanakkede højere. Havde flere eksempler og måske færre spørgsmål."
"Der var for få formler og udregning inkluderet i undervisning"
"Rigtigt fine forlæsninger og opgaver. Der må godt havde været flere eksempler til forlæsning."
"Lidt flere générale formler til hjælp med opgave regning"
"Flere tavle eksempler til noter kunne være dejligt :)"
"Nogle regneeksempler på tavlen vil også være godt. Lidt mere avancerede og tekniske forklaringer er velkomne"
"Hvis du puttede en kahoot ind som afslutning i stedet for en opsummering, så er alle 100% på og så får en del lagret det bedre i hjernen" (Kommentar: Den kursusansvarlige som tager det meste af undervisningen slutter alle forelæsninger af med en Kahoot! Multiple choice quiz for at teste de studerendes læringsudbytte)

2) Feedback relateret til faser fra teorien om didaktiske situationer
2a) Devolution
"Det kan til tider være svært at forstå hvad der menes med spørgsmålene eller om vores forslag er rigtige fordi du ikke er klar i spyttet"
"Først forklaring om træs opbygning var meget hurtig, man kunne ikke nå at tegne med. Men Forståelsen for opbygning er god nu"
"Nogle gange hjælper det at fortælle resultatet først, da det giver et overblik. Fx fortæl sammenhæng mellem træ opbygning set udefra. Super"

2b) Handling og Formulering

"Nogle gange tror jeg godt, diskussionen med sidemanden kunne være sparet for så at komme hurtigere videre, uden man ville misse noget"

"Generelt meget fint En forbedring kunne være at bruge lidt mindre tid på diskussion"

"Superdygtig og gør det hele let at forstå. Men der var lidt for mange 'opgaver med sidemanden' synes jeg :-)"

"Lidt for meget inddragelse – man bruger meget tid på at høre på forkerte svar."

"Godt med at stille spørgsmål ud, så vi deltager aktivt. Evt nogen fysiske prøve"

"Fint at du giver god tid når man skal svare på spørgsmål. Det gør at flere kommer på banen."

"Dog giver den gode tid til at svare på spørgsmål at flere byder ind. Undervisningen går bare også lidt langsom."

2c) Validering

"Godt at du opsummerer efter vi har svaret på spørgsmål, så man ikke er i tvivl om hvad der var rigtigt/mest vigtigt"

2d) Institutionalisering

"Gerne mere uddybende svar på såpørgsmål, gerne med eksempler"

"Fra første undervisningsgang, kunne jeg godt tænke mig at der blev vist på et rigtigt stykke træ hvordan styrken kunne bedstemmes fra vinklen"

3) Feedback relateret til undervisningsstilen

"Super godt. God entusiasme."

"Du virker frisk, og generelt holder du undervisning spændende."

"Egentlig gik det meget fint, det eneste lidt shaky var ekstra spørgsmålene som du ikke var så god til men det kommer med underviser erfaring"

"Struktureret slideshows som er nemme at forstå. Generelt gode og spændende forelæsninger"

"Synes godt om strukturen. Kunne godt følge med hele vejen"

"Derudover har det været en fin undervisning"

"Mega fed entusiasme! Måske lidt bedre forklaring af CLT's banebrydende egenskaber"

4) Andet

"Opgaverne hang ikke sammen med forelæsning/forberedelse da vi kun skulle læse til x-antal sider."

"Husk at sammenholde opgaver med læsestof og undervisning. Mht. opgave 7, var denne til dels sammenholdt med læsestof for 8. undervisning."

"ikke været specifikt nok ift at kunne bruge det til opgaveregning. For logisk ift vand i træ er noget skidt for svampe osv :) mere dybt"

Part V

Activation of students in class

9

Student activation and active learning

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Summary. Student activation and active learning have been proposed as tools through which students acquire knowledge and develop problem-solving skills. On the other hand, traditional teaching is still preferred in Physics courses with abstract and theoretical content. By employing student activation, I intend to explore whether the latter improves the student performance in theoretical courses.

Motivation

Being a theoretical physicist, I have thought by applying traditional teaching methods (i.e., with minimum involvement of the students). Nevertheless, when teaching, I encouraged discussions with the students both offline and at the end of the lecture.

A wide branch of the literature proofs that, through case-based learning, students develop technical competences as well as boost their problem solving skills and easily reach higher levels of abstraction ("Case-based and Problem-based Teaching and Learning", 2018). As shown in Figure 9.1, a teacher-centered approach corresponds to a minimum potential for the learning outcome of the students (Rienecker, Jørgensen, Dolin, & Ingerslev, 2015), while a problem-based teaching, requiring the maximum participation from the students, allows the best learning outcome (Shulman, 1996).

It has been empirically proved that once students become used to be an active part of the lecture, they find the interactive approach more engaging (Egidius, 1999; Pettersen, 2005). Students experiencing active learning

generally have higher marks than students used to traditional methods. This is related to the fact that some competences (e.g., critical thinking) are more difficult to develop through passive learning. The active involvement of students strengthens meta-cognitive and reflective academic competences (Wassermann, 1994).

The main challenge of employing student activation is to encourage the students to step out from their role of passive listeners (Barrows, 1996). At the same time, the outcome of this approach is strictly related to the degree of involvement of the students. Noticeably, the employment of active learning methods gives an immediate feedback to the teacher on the level of understanding of the students.

Another form of student activation revolves around the peer feedback and related group work. The student benefits from working with peers and of the peer's feedback (Boud, Cohen, & Sampson, 2001). Group work enables students to delve further and deeper into disciplinary problems because the more students the more facets of the same problem can be covered (Savin-Baden & Major, 2004).

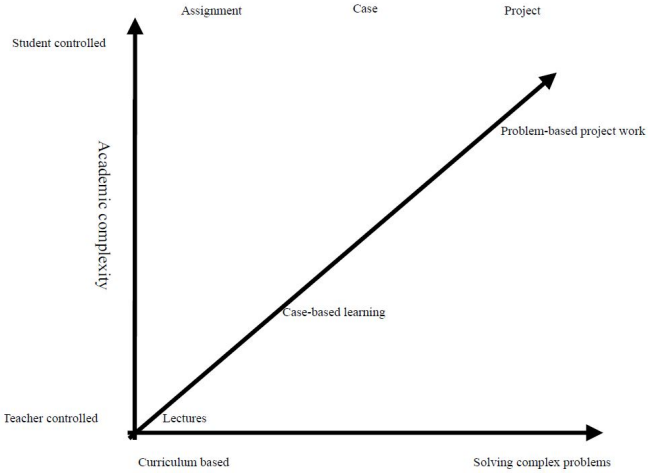

Fig. 9.1. Teacher-centered approach vs. student-controlled approach. Figure adapted from Rienecker, Jørgensen, Dolin, and Ingerslev, 2015.

Through this project, by trying out different tools for encouraging and engaging the participation of the students in theoretical lectures, I explored how the learning performance of students is affected with respect to traditional methods. I also aimed to use these same tools as a way to receive a prompt feedback on the learning level of the students and on the quality of my teaching.

Project description

I taught the course "Gravitational Dynamics and Galaxy Formation." This is a course of the first year of the MSc Program in Physics. The number of students was about 12 and I shared the course with other two teachers. Each teacher was responsible for a thematic module. Each module was independent from the other ones. I coordinated with the other teachers the connections among modules and stressed those during classes. My task was to introduce the physics of the Early Universe and discuss the role of dark matter particles in the formation of large-scale structures in the Early Universe.

In order to engage the students, I alternated the following during my lectures (Barrows, 1996; Boud et al., 2001; "Case-based and Problem-based Teaching and Learning", 2018; Shulman, 1996):

1. Discussed with the students about the Intended Learning Objectives of my module of the course, in such a way to align their expectations with the course content.
2. Adopted a continue dialogue during the lectures in order to encourage the students to think critically beyond the equations.
3. Assigned a research-based project to the students to be solved by the end of the thematic module during classes and within small groups.
4. Employed the peer feedback on the solution of the problem (then institutionalized by myself).
5. Involved the students in summarizing the take home messages of each lecture, in order to evaluate their level of understanding.

I tried to create a welcoming environment for the students to be active and relaxed. First, I introduced the Intended Learning Objectives and asked the students to present themselves and comment on why they had chosen to attend this course. This helped to align my expectations to the ones of the

students and at the same time helped the students to grasp what to expect from the course.

I divided my thematic module in two parts. In the first part, I introduced the theoretical framework useful to work on the research-based project. In the second part, the students worked on the research-based project during classes. The students were allowed to work on the project within small groups and discuss among themselves the results. On the basis of the project results, I extrapolated the takehome messages at the end of the module and institutionalized them.

While the second part of the course required an active engagement of the students, the first one was meant to introduce the theoretical notions. However, also in the first part, I established a dialogue with the students. For example, I asked the students to guess which results we should expect or gave them small problems to be solved during the lecture. Some of the questions I asked required a short and direct answer; some others required logical thinking and more thought. In the latter case, I gave them a few minutes to discuss the problem among themselves and think about the answer. I then guided the students towards the solution. Given their level of participation, I had the feeling that the students were clearly involved and paying attention. Moreover, I stimulated the participation of everybody in the class.

At the end of each lecture, I asked the students to write down a note on the main notions that they had learnt and to hand it in before to leave the class. I then started the following lecture by summarizing the take-home messages from the previous lecture. This was a very useful tool for me to catch the concepts that were poorly understood and evaluate whether the main concepts had passed through.

During the last week of my module, the students were assigned a project on which they had to work in groups. The project was involving many of the concepts introduced during the theoretical lectures in the first part of the module. The students worked during classes on the project and I encouraged them to use oral peer feedback and discuss among themselves the solution. I then institutionalized the project solution and main outcome during the last lecture and contextualized it within the bigger picture of the research field.

I motivated why the topic is interesting by using recent research papers. I also used a YouTube outreach movie. My goal was to highlight the main notions beyond a list of equations. I taught by using the blackboard to proceed slowly and help the students taking notes. I then relied on slides to

summarize the main messages and showed simulation images of the formation of large-scale structures in the Early Universe in the presence of different kinds of dark matter relics.

Results and discussion

All students, except for two, were able to successfully solve all the assignments. This gave me hints about the quality of my teaching. Interacting with students, while they were solving the project and the assignments, also helped me to understand the notions that resulted more critical to be understood from the students.

The fact that the second part of the module was research based helped the students to grasp the importance of the theoretical notions presented in the first part of the module. I asked questions (either requiring a short answer or a longer one) to engage the students and let them think about possible solutions to the problems I was posing. They were all actively involved in the lectures and looked very interested.

Employing an active engagement of the students pushed them to reflect on the teaching material and address more complex issues already during classes. The research-based project constituted a link between theory and practice.

I had to carefully weight the project session allowing enough time for the students to solve the project. Working on the project trained the students to apply theoretical knowledge and suggest solutions. In addition, this strengthened the interdisciplinary dimension of their education.

A challenge for me was related to my role as teacher. The active approach required me to be a facilitator of the work of the students. I had to listen the interpretations provided by the students and initiate discussions if they did not arise. I had to pay special attention to the level of the discussion, also during the peer feedback phase, to sense when the students were in need of assistance.

Another challenge related to the active engagement of the students concerns the amount of theoretical notions that can be thought in a course. Given the active participation of the students and the time required to solve problems, I realized I could teach far few notions than if I had relied on traditional teaching. On the other hand, I found the learning quality to be higher.

Although all students were actively engaged and they easily established a dialogue with me, it was more difficult to trigger a dialogue among them. This was a limitation also in the second part of the module, when the peer feedback happened into small groups of students that formerly knew each other.

I mostly evaluated the outcome of this experiment through the direct feedback from the students. In fact, dealing with a small group of students, helped me to establish a connection with each of them and clearly evaluate their learning performance.

The project and the tools I intended to use for this project were discussed beforehand with my department supervisor and educational supervisor that also acted as observers in some of my lecturers. They supported my ideas and agreed on the overall positive outcome of this experiment. They also gave me small practical suggestions to encourage the students to be active during the class. For example, I was suggested to specify the nature of the answer I was expecting (i.e., a yes/no answer or a more elaborate one) when I posed questions to encourage a safe environment and also to walk around the class to oblige the students to look at each other and foster interactions among themselves.

Conclusions and outlook

Overall, my experiment led me to conclude that the active engagement of students is a positive tool to their learning, although it reduces the amount of notions that can be taught. Almost all students were actively engaged in answering and discussing in the class. When asked to solve exercises or work in groups, the students actively worked on the assignments.

I got immediate feedback on their learning as the students both answered properly to all questions, exercises, and the final summarizing notes were mostly correctly written. This means that the fact that I constantly challenged the students in class helped them to keep their attention high and learn about the main messages. This would not have been possible by employing passive teaching methods.

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10

Activate students in large classes and enable lasting motivation for students after lectures using digital learning tools

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Justification and goal

Problem motivation and justification: The lectures in the course are frontal lectures and allow less sophisticated interaction with 230 students. The project aims to increase the degree and intensity of interaction and student activity in the lecture. Furthermore, it seems that the students' engagement rapidly drops after leaving the lecture hall. The students are IT affine and already involved in online tools for collaboration and learning.

The goal of the activity: Higher intensity of students' interaction and involvement in the lecture by using digital learning tools.

Background and setting

My course is a first-year bachelor toolbox course with 15 ECTS in block 3 and 4. I teach theoretical and abstract contents in my lecture and their application in tutorials. We structured our exercises in a way that we initially do not allow any freedom and students, in the end, have a maximum degree of freedom and responsibility. Students have the first four weeks individual exercises with personal feedback from teaching assistants to achieve the similar knowledge and skill level for all students. Then, students start to work in groups of three students on a project in which they easily extend an existing system by applying their knowledge from the lecture. In block

4, students are working on a project with a given goal, which is also part of their exam. The exam is summative and consists of a written group report on their block 4 project with individual contributions, an oral presentation on the group results, and an individual oral discussion about the project and course content.

We have 230 students attending our course and are two teachers (25%, 75%) as well as nine teaching assistants. The lecture is mostly presentation slide-based with frequent orientation slides and self-tests.

General problems, constraints, and challenges of my course and the project are: *(1) the students are not socialized to the university life; (2) there is no textbook which covers all aspects of the lecture; (3) students are in a transition phase in which they have to develop their learning strategy; (4) computer science students do not read the curriculum material; and (5) the auditorium in Universitetsparken 1 is suboptimal for modern lectures (acoustic, physical access, etc.).*

My goal is to increase the interaction in the lecture between topic, student, and teacher as well as getting immediate feedback on their learning progress by using a student-response system (SRS). The students are used to the system and participate in quizzes. My conclusion on the questions in the quizzes is that they have to be even more precise and challenging. Even though, about 60% of the students in the lecture participated in SRS activities.

Each lecture starts with an overview of the intended learning outcome (ILO) (Rienecker, Jørgensen, Dolin, & Ingerslev, 2015) and views on a topic map to locate the current lecture topics. I provide three ILOs per lecture (2x45 minutes) which students can use for their exam preparation.

The teaching-learning activities (TLAs) are now sequential form, which might be desirable from a didactic point of view. The TLAs are clustered around guiding topics and form a sequential structure. Lectures and assignments are directly linked because the assignments consist of two groups of exercises. The first group has a direct relation to the lecture content on an abstract and isolated topic and has to be done by individual students. The second group builds on top of the first one and applies the specific ILO to their practical project as group work. Exercises contain an individual analysis and synthesis part in which students will apply their knowledge. Additionally, we use a cognitive anchor for the content in block 4, because the exploratory projects in block 3 fail in most times. The group project in block 4 is successful because students can apply the content from Block 4 and avoid the mistakes done in block 3. Exercise assignments can

be included as examples in the lecture to tighten the linkage between both learning activities.

The lecture uses the exercise assignments published before the lecture as examples, presents and discusses their solutions. Furthermore, cognitive anchors, e.g., self-experienced project failures or problems, are used to link lecture and exercise content to practical experience of the students. Guiding examples throughout the lecture series are the student projects.

I would like to increase the dialog with a broader audience in the lecture by giving the students more time, e.g., 2-5 minutes, for answering my questions, and also repeat and rephrase questions to include more students in the dialog. Summing-up the activity results and reuse throughout the lecture offer many potentials to support the learning activities. Walking-around through lecture hall during these activities gives me feedback on the individual learning progress.

Description of activity

Project activity: I decided to do an empirical study on the parameters of a digital learning activity. The study is restricted to the same course but offering the advantage of comparable results. I borrowed from the idea of peer instruction (Crouch & Mazur, 2001; Mazur & Hilborn, 1997; "Peer Instruction", 2018). Peer instruction is an interactive teaching technique by Eric Mazur. He developed his version of this practice to address his students' struggle to apply factual knowledge to conceptual problems. In his technique, multiple-choice conceptual questions are posed at key parts of the lecture. If the majority of the students' responses are incorrect, they are asked to turn to their neighbor to convince them of their answer. Peer instruction works on the theory that students at similar cognitive levels can at times explain content where educators may experience the "expert blind spot" (Wiggins & McTighe, 2006). Mazur claims his technique works best if students prepare before class and then test their application of knowledge in a class where they have opportunities for rich feedback (self, peer, and teacher).

My motivation to use peer instruction are: Mazur (Crouch & Mazur, 2001; Mazur & Hilborn, 1997) has reported substantial learning gains. It has been successfully transposed from Physics to other disciplines, e.g., humanities. Peer instruction is considered a form of the flipped classroom

and provides a structured way to guide student preparation, in-class active learning and rich feedback opportunities.

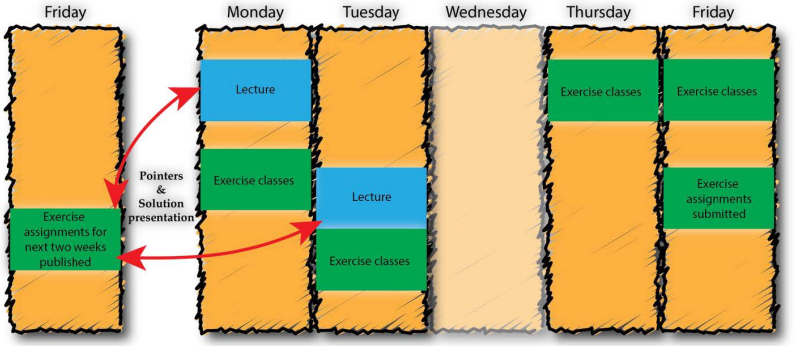

Fig. 10.1. General week plan for learning activities

I designed the activities according to the following guidelines ("Peer Instruction Tipsheet", 2018):

1. Students are provided with materials in the week before the actual lecture for preparation (cf. Figure 10.1: General week plan for learning activities).
2. After a brief lecture (10-15 minutes) I asked students a challenging conceptual question.
3. Individuals think for 1-2 minutes and groups think for 2-12 minutes.
4. Ask students to vote on their answer (SRS, Mentimeter).
5. If under 30% are correct then revisit the concept. Ask individuals to think and revote.
6. If 30-70% are correct, engage in peer discussion (pairs or small groups), then students re-vote. If over 70% are correct, then explain the answer and move on. If they are still struggling, revisit the concept (e.g., mini-lecture with backup slides) and repeat the process.
7. Remind students of the relevance of the activity to broader outcomes (industrial applications or use cases).

The biggest challenges I had with the peer instruction were: design sufficiently challenging conceptual questions to promote higher order think-

ing. Students need to prepare before class and have sufficient background knowledge to take on the challenging questions. The hardest task personally was not to give away the answer too soon and allowing for students to think, debate, and discuss.

I designed the questions according to the "Taxonomy of Clicker Questions" ("Taxonomy of Clicker Questions", 2018) based on Derek Bruff, "Teaching with Classroom Response Systems: Creating Active Learning Environments, 2009" to define characteristics of good questions fitting to the intended learning outcome. I adjusted the degree of difficulty incrementally based on a higher abstraction in Bloom's taxonomy.

Students were allowed to enter questions to the teacher and the audience during the lecture using Mentimeter. I picked up these questions in regular time intervals and discussed them with the broad audience. It also provided a good way to interact with students and deviate from the form of multiple choice questions. During the break between block 3 and 4 students could work on an ungraded software project with predefined tests which acted as automatic feedback to the students.

During the lecture series, I modified variable parameters of the peer instruction: the number of student activities (0-3) per lecture unit, the length of the student activities (1-12 minutes), the content composition of the student activities, and classical vs. digital tools. The tools used are Mentimeter (mentimeter.com), videos, and classical non-digital activities, e.g., blackboard, pyramid activity. The experiments were conducted during block 4 for coherent sampling. Block 3 was used to introduce the tools and make the students accustomed to the selected tools in lectures on dates 6.2./12.2./19.2./20.2./19.3.2018. The relevant experiments in block 4 were:

- 5 Units in block 4 with a digital interactive tool (24.4./30.4./7.5./8.5./27.5.2018)
- 5 Units with a non-interactive digital tool (MS PowerPoint slides for student activities)

Evaluation

Results

I received the results through individual feedback and survey as well as course evaluation results. Students were very positive about introducing

peer instruction in block 4 (multiple mentions in course evaluation and personal feedback).

- The students preferred *7-10 minutes* for group activities and *2-5 minutes* for the discussion.
- The individual activities had the highest participation rate with *2 minutes*.
- The number of participants was with *one and two blocks of questions* high but dropped significantly to a half for a third one.
- Students preferred an *incremental* increase of the semantic complexity of questions.
- Students had *no preference* concerning digital or analog tools used in the activity.
- Mild *variation* of the methods was mentioned as an important success factor.

As an example: in the lecture on "Code quality and awareness" on May 28th, 2018 (cf. Appendix), a group activity of 10 minutes for groups of three students as well as a shorter individual task is included. Students should collect relevant quality attributes of software/code for a use-case on office software replacement. The following collection of found quality attributes covered roughly 80% of the top-level non-functional requirements/quality attributes. An SRS (64 active students) supported to reflect on how developers in general approach risks (70% of students answered correctly).

Interpretation

The results have low validity and significance. The project only considered one course with five lectures using digital and five lecture using non-interactive tools with the same setting and task profile. Nevertheless, the comparison of the student evaluations of the course and its predecessor shows an improvement, which has been mentioned by the students. The exam results indicate a significant improvement in the student learning.

Discussion with departmental supervisor and outcome

My departmental supervisor is also co-teaching the course and has direct insights into the results. Also, my departmental supervisor and Universitetspædagogikum supervisor have attended some lectures and provided an additional objective source of feedback. Their feedback was to increase the

dialog with a broader audience in the lecture by giving the students more time, e.g., 2-5 minutes, for answering my questions, and also repeat and rephrase questions to include more students in the dialog. Summing-up the activity results and reuse throughout the lecture offer many potentials to support the learning activities. Walking-around through lecture hall during these activities gives me feedback on the individual learning progress.

Pedagogical reflection

The course "Software udvikling" uses constructive alignment and enables constructive learning with aligned teaching outcomes. The course integrates teaching, learning, and assessment better than the predecessor course. The general problems and constraints of the course and its environment are under control. The assessment applies to different perspectives of the course and the encompassed study program. The feedback, which I received from my mentors and through student evaluations shows a significant improvement. I made important progress in my teaching qualities and am now more confident about my teaching methods including now peer instruction as a very natural method of using digital tools.

The project activity was not the only changes in the course. A further improvement was to break up the lecture in 7 minutes slices, systematic didactic reduction of lecture content, and the usage of topic-related, ironic comic strips for preparing the learning activities and easing the transition. Videos of tutorials and web links to further information were widely used by the students.

The usage of peer instruction, as a soft version of the flipped classroom, was an important part of the project because I would like to introduce flipped classroom as a teaching method for the coming course in which I will be the course responsible.

Acknowledgments

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A

Appendix

Example lecture outline ("Code quality and awareness" on May 28th, 2018)

Time in hours	**Learning activity in time slot**
0:00-0:15	Introduction code quality and awareness triggering
0:15-0:30	Group work and discussion (10 mins + 5 mins) – Product qualities for a word processor in the company
0:30-0:45	Product quality attributes
0:45-1:00	Break 15 mins.
1:00-1:10	Defects and code improvements
1:10-1:15	Individual activity (2 mins) – Prioritize product qualities for SpaceTaxi project
1:15-1:30	Software quality assurance
1:30-1:45	Binder and motivation for next lecture
1:45	Lecture end

Part VI

Formative assessment of students

11

Formative assessment of Bachelor and Master student's supervision

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Formulation and Justification of the topic chosen

One of the most challenging parts of student's supervision is to have the ability to formulate a good assessment. This one should help students to realize how much they have learned and, consequently, to the supervisors to improve their teaching skills (1, 2, 3).

In my research field, we interview students before we accept them in the laboratory under our supervision. During the interview we have the opportunity to know about students' background, expectations and social environment. Based on this information, the supervisor can adapt the contract and intended learning outcomes (ILOs) in order to get the best alignment.

The challenge pops up in the assessment of students. They are formally assessed on a report and a defense of their thesis, but generally they miss a formative evaluation while they are in the laboratory performing experiments. Consequently, I have found really interesting for my final project of the Universitetspedægogikum course to focus on activities that can improve this part of the supervision in a research group.

Description of the experiment

I will supervise one bachelor and one master student during block 4 together with Professor Stine Falsig Pedersen (I will do 75% and Stine 25% of supervision, respectively). For both students, and in agreement with the other supervisor, I would like to implement several assessments along the

block that will allow us to follow the scientific skills progress that students should learn in order to reach the ILOs.

The activities programmed for my supervision are the following: first, one individual meeting with each student; second, several assessments as experiment designing, meeting or exam preparation; and finally, exam evaluation. As described in the following points:

(a) One individual meeting:
- The ILO of this early starting individual meeting is to align the main learning objectives of students and supervisors.
- To achieve this goal, we will talk about our own expectations, student's supervision needs and learning objectives.
- This meeting is very important in the sense of establishing main points and getting agreements in the main terms of daily supervision. This meeting will also be very relevant to know the background and social environment of the students.

(b) Assessments:
- The ILO of these assessments is to motivate the students to get a deeper understanding of the laboratory techniques and better knowledge of the project. Each assessment shows several specific ILOs that will help to reach the general one. The specific tasks are described in detail for each assessment.
- First assessment – Experiment designing.
  - Both students should review 10-15 papers of the literature focusing in the techniques that have being used. These papers have been chosen considering its relevance for the project. (ILO - get familiar with the scientific literature)
  - Extract conclusions from previous studies by former laboratory members in order to use the information for new experiments. (ILO - learn how to be critical with previous studies and be able to analyze results)
  - Elaborate a working plan for the experiments that they will perform in the laboratory and discuss with the supervisors. (ILO - be able to organize their own experiments and explain the decisions with the supervisors)
  - The Master student should lead the literature search and discussion due to the experience and the higher level of exigency that we should have with this student. (ILO - improve the teamwork skills and leadership of the master student)

- Second assessment – Meeting preparation.
  - Both supervisors and students will meet every two weeks after the first month of working.
  - The objective of these meetings is to train students in data presentation, discussion and criticism of their own performance in the laboratory. (ILO - be able to present their data in a scientific format and improve their scientific skills)
  - During the meeting, students should be able to present and explain their own results and the biomolecular techniques that they have been using to get the results. They should also be able to discuss with the supervisors about future perspectives of the project and new experiments. (ILO - improve their data analysis skills and their understanding of the project. The demand level will increase as far as the project evolves)
- Small assessments – Deeper knowledge of biomolecular techniques.
  - During my daily supervision, I will ask to the students basic questions that they should answer to improve their knowledge about basic biomolecular techniques (as buffer composition, basic biomolecular concepts, etc). These assessments should be answered in an informal meeting the next day (or as soon as possible) in order to discuss about the technique and apply this knowledge in the consecutive experiments. (ILO - motivate and provide them with more tools to modify protocols gaining deeper understanding of basic biomolecular concepts)
- Exam preparation – Meeting to prepare the oral exam.
  - In this meeting, we will go through essential concepts that students should have learned during the time in the laboratory. They can do a rehearsal of the presentation that they would prepare in order to fix small mistakes and improve their presentation skills in a relax atmosphere. (ILO – give the students feedback about their learning and reinforce the main concepts)

(c) Exam evaluation:

- I will prepare several questions with varying difficulty level in order to evaluate the learning acquisition of the student. Both open and closed questions will be design to get a better picture of the student strengths and weakness (4, 5, 6).

- Another important focus will be to coordinate the focus and the duration of the exam. In order to achieve that I will discuss with the other supervisor about the questions that I have prepared and about the structure that exam should have.
- Additional goals during the exam will be to create a relaxing and safety environment for the student. To achieve this, I will follow the next points:
  - Explanation of what will happen during the exam, by describing its structure to the student at the beginning of the evaluation.
  - Creating a pleasant and friendly atmosphere with constructive comments about the presentation and the written report in order to break the ice. Also I can introduce some inquiries with a general context and breaking down the difficult questions if the student requires it.
  - Using starting questions with low level of exigency to get a more relaxing atmosphere (easy opening; 4, 6).

Development of the experiment and discussion

- As the individual meeting we have used the interviews of students as a platform to talk about students' background and expectations. We also talked about their specific projects, our expectations for their performance, and what they could expect from us. In this particular case, and because both students worked at the same project and learned at the same time the techniques, we also had an initial meeting with both of them. As an outcome of this meeting we made an agreement about the supervision. The conclusions of the meeting were:
  - They would work independently as soon as possible.
  - They would share experiments at the beginning of their projects until they have learned the biomolecular techniques to work alone in the laboratory.
  - I would be the daily supervisor and we would have meetings with both supervisors every 2 weeks.
  - They asked for a close supervision at the beginning and more freedom at the end (request that was in agreement with supervisor's expectations).

  - Both students looked very enthusiastic and motivated with the topic of the project and the supervision plan.

- Regarding the assessments, they helped to improve the students' skills in experiments designing and meeting preparation. In particular, the first assessment was more challenging for them due to the lack of familiarity with experiments designing based on literature and previous studies. In order to provide some guidance, I gave them multiple examples of protocols, previous master theses and several relevant papers to assist them in the broad literature of the project. We had also several short meetings discussing protocols in order to highlight the good performance and the important points that needed some improvement. The meeting preparation assessment improved their scientific skills by presenting their data in every meeting. In the last ones, in the case of the Bachelor student, she was able to discuss the results and suggest new experiments that the Master student should continue. In both cases, they were able to work with certain grade of independence in the laboratory when the tasks to carry out were well defined. Unfortunately, in the case of the small assessments they did not look very useful or very pleasant for the students. I decided to let them choose if they want to get insight into deeper knowledge or not without any consequences or pressure.
- Concerning exam preparation, I helped the bachelor student to prepare her exam a week in advance. It was an intense session where we discussed the important concepts that she should know and how to improve her scientific vocabulary in order to explain the concepts and results that they have obtained during the 3 months. In my opinion, this meeting was really fruitful and helpful even though the student told me that she had a recent personal difficult situation that prevented her from focusing on the exam.
- Finally, I was the co-censor of theorical part of the PUK exam of my bachelor student (before she started with the laboratory practice) and the co-censor of another bachelor external student (in this case evaluating the last defense of the project). In both cases, but especially in the last one, I was able to achieve the three main points of exam evaluation explained in the experiment description (evaluation by open and closed questions, management of exam time, and creation a safe exam atmosphere). Before the exam, I had a meeting with my departmental supervisor (co-censor in the exam) in order to adjust the time and the level of the exam; and after the exam, to get feedback about my per-

formance. Both meetings were really helpful for me and allowed me to improve myself efficiency. The conclusions were that I was able to create a relaxed and safe atmosphere during the exam, being clear about the pace of the exam and creating a good balance between questions that the students could fully answer, and more difficult questions. In addition, I had a very good understanding and use of the principles of teaching for higher education and grading system.

Considerations on the outcomes of the experiment and future ideas

In my opinion, most of the experiment was really successful and helpful for the students and for me as a supervisor. The formative appraisal of the students facilitates us to follow better their achievements and adjust the level of exigency without losing students motivation. On the other hand, the small assessments were not entirely accomplished. The students did not show interested for them. In the future, because I consider that these small assignments will help in higher degree the learning process of the students, I will improve them as follow:

- Showing the students future relevance of the assignments, what they can learn from them.
- Emphasizing the scientific and medical context of the assignments.
- Inviting the students to be more involve in the formulation of these assessments choosing the way to present them and saving part of the meeting time to discuss them.

Finally, I would like to implement a written evaluation of my supervision. The conclusions from this project have been taken from informal discussions with students and my supervisor but a written feedback will help me to evaluate my weak and strong points with the intention of improving myself efficiency. Furthermore, I think it would be a good exercise for the students to evaluate my supervision and participate more in their own learning process.

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12

Organizing peer-feedback for a group report

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Introduction

The assessment of the learning process can be done in two different ways: summative (certification purpose) or formative (learning purpose). Summative feedback is the evaluation of the students' learning at the end of the course or project, whereas formative feedback is the monitoring of the students' learning during the learning process, so both students and teachers can use the feedback to improve its learning and teaching respectively. Formative feedback is described as an efficient means of stimulation and enhancing student learning in education systems (Black, 2015).

Feedback is an essential element on the learning process, which allows students to reflect on their own learning, identifying weaknesses to improve it and providing the students the opportunity to self-assess their skills and capabilities. Furthermore, it is insufficient to provide feedback only at the end of the course of project that tells students what they did wrong. Fortunately, the provision of feedback had substantially changed in the last years, from a passive student receiving feedback from the teacher, to a more active participation of the student in the feedback process.

Feedback can be very diverse, including individual feedback, generic feedback, informal feedback, self-evaluation or peer feedback, and the method to deliver the feedback can be written feedback, annotations, oral feedback or seminar discussion. Moreover, feedback can be given by tutors, mentor or peer. Peer feedback involves students giving feedback to each other to grade their work or performance using relevant criteria (Boud, Cohen, & Sampson, 1999), so the students learn from both giving and re-

ceiving feedback. Several studies have reported the benefit of the peer feedback (Liu & Carless, 2006; Topping, 2009; Van den Berg, Admiraal, & Pilot, 2006; Wheater, Langan, & Dunleavy, 2005). According to Falchikov (Falchikov, 2013) the benefits of peer feedback for students are: i) high quality learning (higher transfer of learning, reflection, better understand of the assessment criteria and better understand of the concept from seeing other students' successes and weaknesses), ii) skills development (negotiation and work cooperatively), iii) personal development (higher responsibility, autonomy and independence), and iv) affective disposition (higher student confidence and motivation and less stress). While the peer feedback also has some benefits for the teachers, because peer-feedback is an efficient and effective way to monitor the progress of the students reducing the lecturer workload and provide and extra feedback to the students.

The aim of this study was to investigate how the implementation of a peer-feedback activity on written reports in groups influences the learning process, and what is the students' perception in giving and receiving feedback from their colleagues.

Methodology

In this year 2017/2018, I taught in Environmental Impact Assessment course (EIA) (LNAK10010U) that is a 7.5 ECTS course taught in block 4 and offered in seven different MSc programmes at Copenhagen University (UPCH). The aim of the course is to introduce the components and the structure of an Environmental Impact Assessment, as well as discuss how national guidelines and requirements for EIA influence the outcome. During the course, students work in-group in six exercises on the same case (road construction in Zambia). Every exercise is about one of the steps that a consultant has to follow when carry out a real EIA report. In all these exercises, the teachers give feedback to the students. After that, students have to develop two reports for the exam. The first report is the Term of Reference (ToR), which is the document that sets out what the EIA report has to cover, the type of the information to be submitted, and the depth of analysis that is required. In this case, every group develops the Term of Reference for a different project. Later, we swap the ToR between groups, so they have to develop a full EIA report on a different project based on the ToR elaborated from another group. Both reports are the written part of the exam, where there is also an individual oral exam where both reports and

some general questions on the EIA process are discussed with the student. After the oral exam, the teachers provide feedback for both reports the ToR and the EIA for the group.

In general, the students evaluations from the course in the previous years are good, but they claimed for more feedback during the course. Therefore, the development of peer-review session in the ToR could provide some benefits for the students because they receive more feedback in the report that is part of the oral exam, but also they can learn from the revision of similar reports, and the revision can also help the students to identify weaknesses in their own reports. During the planning of this course, the activity was discussed with the previous teacher of the course who taught the part of the course that I teach this year, but also with the other teacher of the course. Both of them have been running the course for more than 10 years and they agreed that the peer-review session is a good activity that can help the students to learn how to develop a good ToR. They also suggested the importance of giving a guideline to the students on how to carry out a good revision.

Two weeks before the exam when the students were working on the EIA report, I did a peer-feedback session. For this session, 24 students were present. Firstly, I did a short introduction explaining the rationale and the benefits of having a peer-review. After, I gave the exercise instructions and I gave the students a guideline (Appendix A) on how to develop the revision, and which criteria or questions they have to follow to review the Term of Reference based on the requirements for this report and the ILOs of the course. Finally, when all the revised reports were uploaded in Absalon, I handed out a questionnaire to the students (Appendix B) to evaluate the activity and get their perception of giving and receiving feedback for a peer.

Results and Reflections

During the peer-feedback session, students worked actively revising their colleague's reports, and showing a good acceptation of the activity. The results from the questionnaire showed that the peer-review activity helps the students to understand better the purpose of the ToR report, being around 70% of the students agreed (4-5) with this statement (Figure 12.1a). Similarly, around 87% of the students manifested that also the peer-review activity helped them to identify weaknesses in their own report (Figure 12.1b). The students also learnt different ways to develop a ToR with the revision

of the others colleagues' ToR (Figure 12.1c). These three statements confirmed that the review of similar report helps the students to understand better the purpose and required information to develop a good ToR.

The next statement was if the peer-review activity helped the students to learn how to evaluate a ToR, around 42% replied that they did not agree or disagree, whereas 50% of them said that they agreed with this statement (Figure 12.1d). This statement reveals that even the peer-revision is a good exercise for students to learn how to evaluate a report; they need more training and practices on how to evaluate a report, which is also an essential skill as an EIA consultant.

The next statement was about how general were the feedback obtained for the students, and in this case, the responses were more homogeneous (Figure 12.1e), suggesting more specific details should be given to the students on how specific should be the comments in the introduction of the exercise. The last two questions revealed that most of the students (70%) agreed with the statement that the feedback from their peer help them to understand better the purpose of ToR (Figure 12.1f), and around 90% said that the peer-review activity helped them to identify weaknesses in the ToR. These statements suggest that in general most of the students were satisfied with the feedback that they received from their colleagues and were positive for the learning process. Later, in the next open question about what was the most useful part of the peer-review, the students said that the activity was very useful to see different ways of doing the same, and to identify strengths and weaknesses in the colleagues' report but also in their own report (Appendix C). Finally, in the statement on how to improve the activity, some of the students suggested that they would like to have an extra time to discuss the feedback given, or even to give a short presentation, whereas some of them claimed for more specific feedback or more detailed information about how to it.

In the course, it was not possible to correct and handle the report again because the report was part of the oral exam. However, in the oral exam all the students answered all the questions about the ToR well, showing that although the report did not get the higher grade, they students knew the process, the purpose and the relevant information to make a good ToR.

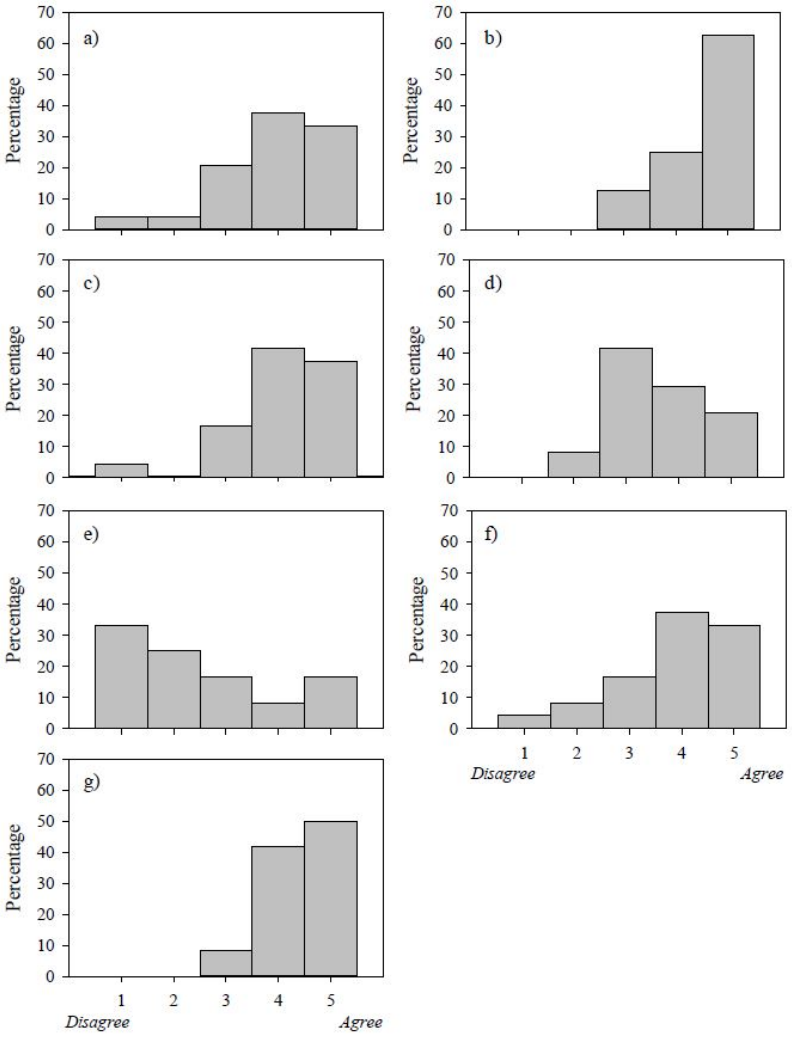

Fig. 12.1. Percentage of students responding the statement described in x-axe (from disagree to agree, 1-5) for the questions: a) The peer-review help me to understand better the purpose of the ToR, b) The peer-review help me to identify weaknesses in my own ToR, c) I have learnt different ways to develop ToR, d) The peer-review exercise show me how to evaluate a report, e) The feedback from my peer are very general, f) The feedback from my peer help me to understand better the purpose of the ToR, and g) My peer help me in identifying weaknesses in my ToR.

Conclusion and Perspectives

It can be concluded that the peer-review activity is a good exercise to give a formative assessment to the students, where the students get more feedback without an increase in the workload of the teachers. Giving feedback to peer makes the students to see others options to develop similar reports, but also to reflect and be critical with their own reports, identifying weaknesses and strength in their own report. The results of the questionnaire show that students would like to have some time to discuss with their reviewer the feedback. Furthermore, for the future I would allocated more time to the peer-feedback including some extra time for discuss the feedback. Finally, to successfully use the peer-activity more specific instruction on how specific the comments should be must be given to the students.

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A

Peer-Feedback Exercise on Term of References - Environmental Impact Assessment

Guideline:

1. Please read carefully the report to review.
2. Use pdf comments option to evaluate the ToR
3. Please remark/comment any positive or negative aspect that you consider in the ToR
4. Please describe the strengths and weaknesses of the ToR
5. Suggestions for improvement.
6. Further comments

Questions to consider:

1. Does the ToR follow the standard structure including at least: Objective and background, activities, impact identification, boundaries of study, staff and timing?
2. Are the objective and background detailed enough to understand the project?
3. Are the main activities and impact identifies in the ToR?
4. How adequate are the boundaries of study?
5. Are the provision for staff and timing realistic?
6. Is there any mention to an alternatives or public involvement provision?

B

Appendix B

Questionnaire

1	The peer-review help me to understand better the purpose of the ToR	*disagree agree* *1 2 3 4 5*
2	The peer-review help me to identify weaknesses in my own ToR	*disagree agree* *1 2 3 4 5*
3	I have learnt different ways to develop ToR	*disagree agree* *1 2 3 4 5*
4	The peer-review exercise show me how to evaluate a report	*disagree agree* *1 2 3 4 5*
5	The feedback from my peer are very general	*disagree agree* *1 2 3 4 5*
6	The feedback from my peer help me to understand better the purpose of the ToR	*disagree agree* *1 2 3 4 5*
7	My peer help me in identifying weaknesses in my ToR	*disagree agree* *1 2 3 4 5*

8 What was the most useful part of the review process?

9 What could have been done better?

C

Students answers for the open questions 8 and 9 from the questionnaire (Appendix B)

8 What was the most useful part of the review process?

1. To have an idea on what we miss in our ToR
2. It was very good with the review questions that we can use to give feedback to the ToR
3. To see different ways of doing ToR, what to specify and where put emphasis on, etc.
4. To see how someone else did the ToR, and to repeat the necessary parts of an ToR
5. It was useful to consider the ToR and five feedback
6. Getting an opinion from other point of view and seeing their perception of ToR
7. The review process allowed me to reflect on what the other group did well that we could have also incorporated. It is useful to see different approach to the ToR structure
8. Learning about weaknesses and strengths is helpful for future reports
9. Good exercise with giving and receiving comments, to have a clearer picture of our own ToR and the other group´s ToR. Also good that all the comments are available for all of us.
10. I think that talking with my groupmates about the others ToR and see the different opinions. I have like to have a review of our ToR and all the rest from the different groups.
11. To see what other groups' opinion and also when we evaluated other groups´ feedback, we evaluated ourselves at the same time
12. It points out parts of our report that we would not have seen otherwise. Good to have an external voice.
13. To have several people reviewing to get more comment, even though some of them contradicted each other
14. To get different view on how different people write a ToR, to get general feedback, and to get other people view on you work, you learn how to do it better next time

15. To know the structure of the ToR
16. Even though getting feedback is scary, good to acknowledge weaknesses that you can improve on
17. It forces you to reflect on your own ToR and its strengths and weaknesses, good exercise prior to the exam
18. Identifying weaknesses, what information is useful?
19. The possibility of comparing my ToR with a different one what I will need to sue for the EIA in a critical way.
20. Having to look all the papers objectively and try to find both strength and weaknesses of the report
21. To think about different aspect more in –depth and to be trusted in having an evaluator´s perspective
22. Finding discrepancies in what we say in introduction/purpose/description and the rest of the project

9 What could have been done better?

1. Specify whether we are supposed to do it in groups or by ourselves.
2. An actual presentation would have been interesting. Meaning getting question from the review group
3. More focus and repetition of necessary parts and objective of a ToR
4. Have more time to talk with the people who has reviewed our ToR
5. More of a conversation between groups might be nice
6. Maybe a small and short presentation of each review in front of the everybody to share with the rest
7. Maybe give an opportunity for feedback group and original groups to talk and discuss it
8. Some of the comment could have been more specific
9. Shorter time, it took really long time for the different group to get done
10. To actually talk with the other group to understand their rationale and hear their defence for it.
11. More specific questions to evaluate/consider for each section
12. More specific guidelines for the ToR assignment itself would have make a review process more streamlined

13. Maybe discussion in class all together random parts of each ToR
14. Maybe we could have prepared some in advance; that said being "forced" to doing it within a very short time, is an exercise in itself
15. More detailed feedback on specific things