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**Moving Towards Digitalization of Teaching:  
Learnings from Higher Education Course Developments**

Master's Thesis

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AALTO UNIVERSITY SCHOOLS OF TECHNOLOGY PO Box 12100, FI-00076 AALTO <a href="http://www.aalto.fi">http://www.aalto.fi</a>		ABSTRACT OF THE MASTER'S THESIS
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<p>Digital materials are increasingly used in teaching. The question is how teachers can use digital teaching materials in their teaching in the best possible way. This thesis seeks to address the research question of how can digital teaching materials be used in higher education to support students' learning? This research provides new knowledge by contributing to literatures of: Digital teaching materials and their use, blended teaching, and flipped classroom.</p> <p>We conducted a multiple-case study of eleven case courses from the areas of Project Business, Digital Transformation, Operations Management, and Designing. Case courses were taught at Aalto University, Finnish Institute of Technology, EIT Digital, and Oulu University. Some of the case courses used digital materials as part of the teaching for the first time while others had long experience of using digital materials in teaching. We collected data from eleven case courses through 10 interviews, 20 lecture observation sessions, participation observation in 13 case course design meetings, a survey of EIT Digital students, Aalto Online Learning video development process, feedbacks from 4 case courses, and student portal materials.</p> <p>From the cross-case analysis, we derive eight propositions concerning the form of digital materials, the necessary support to adapt digital materials in teaching, benefits such as scalability and implications of those benefits to teaching, different ways to motivate students to complete assignments, and the roles of active learning and feedback when using digital materials. Our propositions also provide new knowledge on the roles of external support organizations in the proliferation of digital materials and how to motivate grade and deadline-oriented students to study. We suggest further research in how to support using non-self-produced digital teaching materials, what is the best way to connect assignments to digital materials that students would study the required materials, and how to best use deadline-orientation of the students to pace the teaching in courses.</p>		
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AALTO-YLIOPISTO TEKNIKAN KORKEAKOULUT PL 12100, 00076 Aalto http://www.aalto.fi		DIPLOMITYÖN TIIVISTELMÄ	
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<p>Digitaalisia materiaaleja käytetään yhä enemmän opetuksessa. Tästä juontuu kysymys, kuinka opettajat voivat parhaiten hyödyntää digitaalisia opetusmateriaaleja opetuksessaan? Diplomityö käsittelee tutkimuskysymystä: <i>Kuinka digitaalisia opetusmateriaaleja tulee hyödyntää yliopisto-opetuksessa tukemaan opiskelijoiden oppimista?</i> Diplomityö tuottaa uutta tietoa digitaalisten opetusmateriaalien käytön, sulautuvan oppimisen ja käänteisen opetuksen -tutkimusalueisiin.</p> <p>Diplomityössä lähestyttiin tutkimuskysymystä monitapaustutkimuksen kautta tutkien yhtätoista yliopistokurssia, jotka käsitelivät projektiliiketoimintaa, digitalisaatiota, operaatioiden johtamista ja muotoilua. Kurssit opetettiin Aalto Yliopistossa, FITech-verkostoyliopistossa, EIT Digital -koulutusohjelmassa ja Oulun Yliopistossa. Osa kursseista käytti digitaalisia materiaaleja ensimmäistä kertaa opetuksessa ja osassa kursseista digitaalisia materiaaleja oli käytetty jo vuosien ajan. Data kerättiin 10 haastattelusta, 20 kontaktiopetustilaisuudesta, 13 opetuksen suunnittelutapaamisesta, kyselystä EIT Digitalin opiskelijoille, A!OLE video-projektista, 4 kurssin kurssipalautteista ja opiskelijaportaalien materiaaleista.</p> <p>Tapausten välisestä analyysistä johdettiin 8 väitettä, jotka koskivat digitaalisten materiaalien esitystapaa, tukea materiaalien tuottamiselle, jotta materiaalit otetaan opetuksessa käyttöön, digitaalisten materiaalien hyötyjä, keinoja motivoida opiskelijat opiskelemaan digitaalisia materiaaleja ja aktiivisen oppimisen sekä palautteen roolia, kun digitaalisia opetusmateriaaleja hyödynnetään opetuksessa. Väitteemme tuovat uutta tietoa kurssien ulkopuolisten tukijärjestelmien merkittävydestä digitaalisten opetusmateriaalien yleistyessä sekä kuinka motivoida tuloskeskeiset ja aikarajaohjautuvat opiskelijat opiskelemaan. Jatkotutkimukset voisivat tutkia kuinka tukea muiden tuottamien digitaalisten materiaalien käyttöönottoa opetuksessa, kuinka parhaiten yhdistää harjoitus oppimateriaaleihin niin, että opiskelija tulee sisäistäneeksi oppimateriaalit harjoitukseen valmistautuessaan ja kuinka hyödyntää opiskelijoiden taipumusta opiskella vasta hieman määräaikaan ennen opetuksen ja kurssien aikatauluttamisessa.</p>			
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# 1 Introduction

## 1.1 Background

Media has recently addressed learning and teaching in Finland (e.g. Opettaja luopui luennoista, 2017, Pölkki, 2018, Saavalainen, 2018), one of the topics has been the use of one form of blended teaching: Flipped classroom. Flipped classroom is about having students studying digital or other materials before lectures and during lectures focusing on assignments and discussion based on the students' pre-classroom studying. The flipped classroom has been employed at the University of Eastern Finland (Pölkki, 2018). According to Pölkki in *Helsingin Sanomat* (2018) over 100 University of Eastern Finland teachers employ flipped classroom in their teaching. They have had positive experiences for learning in flipped classrooms. This has also been received well by students and over 70% of the students there wished to continue studying with the flipped classroom. However, approval is not unanimous as the rest still prefer traditional teaching. All coverage of the new pedagogical approaches has not been positive. Independent learning and topical learning have been criticized when applied to elementary school students (Saavalainen, 2018). The discussion demonstrates that there is a large public interest in how education is handled. There are different viewpoints about why education is important. The public sector is interested in how to educate new professionals for the needs of the. Private persons might be more interested in how their children are educated to provide the best possible starting point in life for their children. Another part of the education discussion is how to facilitate life-long learning (*Jatkuva oppiminen haastaa koulutuksen*, 2019). Automatization and digitalization can replace a lot of employees and there is a need to teach people new skills for them to find new employment. How to do this cost effectively is important for the public economy.

The digital assets are now more available than ever before. Students have access to computers, mobile phones, and the internet so digital materials can be easily accessed. The storage platforms for video storage are improved and easily accessed through the internet almost everywhere. Universities have more assets for digital material producing. The production, storage, and availability of digital materials are greater than before. The possibility to utilize digital teaching materials in teaching has therefore increased compared to earlier decades.

This thesis started with an Aalto Online Learning (A!OLE) funded pilot development Reach-Out Project Videos to produce educational videos for Project Business courses in Aalto University and Finnish Institute of Technology (FITech). The A!OLE pilot produced two series of interview videos from Neste renewable diesel projects and ABB Marine. It also raised questions of which is the format of the videos should be to support learning and how to utilize these videos in the teaching in university teaching? A little earlier FITech had produced a set of 44 educational videos in Finnish and 46 videos in English both covering principles of project management. These videos also could be used in the Project Business teaching of the Aalto University. How would the videos support the learning and how to integrate videos in the courses in a way that they would be effective? In search of answers, we started to study other organizations that had employed videos and other digital teaching materials in their teaching. In addition to other A!OLE pilots, we studied EIT Digital, which is a pan-European educational program to teach digital innovation and entrepreneurship to students, and their use of digital teaching materials in courses. We study courses that have already a lot of experience of using digital teaching materials and courses that develop their approach to the use of digital teaching materials.

The pilot was connected to the Finnish Institute of Technology (FITech) and the Project Business teaching in FITech. FITech is a network university project in Finland that intended to provide teaching to educate future engineers for the needs of industry around the City of Turku area and more broadly in Southwestern Finland. The goal of FITech was to get education established more quickly and cost-effectively using blended and distance teaching from existing universities than to establish new university departments in universities located in the City of Turku. In the fall of 2018, FITech organized 70 courses and had 2100 participants. The Project Business research group at Aalto University participated in the teaching of two project business courses together with other universities in FITech.

FITech teaching was a pulse to start development of new educational videos and other digital teaching materials in Project Business research area in Aalto University, Tampere University, Åbo Akademi and Oulu University. From the perspective of Aalto University, the possibility to utilize digital teaching materials started a discussion of changing the Project Business courses that were offered in Aalto University Department of Industrial Engineering and Management (DIEM). The digital teaching materials could offer an opportunity to change the content delivery to online and then free the time to have more personal contact with the student when contact teaching is scheduled. Use of digital teaching materials offers

an alternative of a traditional lecture where the teacher delivers the content to listening to students to change to be more interactive and get input from the students.

## ***1.2 Research question***

How to keep contact between the students and the teacher? How to support studying effort of the students? How to activate and motivate students to get through the materials? When critically examining the teaching process we can solve the challenges of digitalized teaching and realize the potential benefits of the digitalization. Thus, we pose the following research question:

***How can digital teaching materials be used in higher education to support students' learning?***

In this thesis, the digital teaching materials cover videos, multiple-choice quizzes, digital cases, games, simulations, and other digital teaching material that can be used for teaching and that are employed in the eleven case courses that the thesis examines. The objective of university teaching is to get students to learn which is why learning is chosen to be the objective where digital teaching materials should have an impact. The basic unit of organizing teaching in universities are courses which cover a set of learning outcomes defined for a course. To see how digital teaching materials can support learning overall, we need to analyze the whole course and its structure. By getting too focused on one aspect of the course like digital teaching materials we could offer end up in conclusions that would hinder the overall learning during the course. Therefore, this thesis studies courses as a basic unit to address the use of digital teaching materials in support of learning. We will use a term learning event as an overall term to describe all manner of learning situations. We include to a learning event organized teaching such as lectures and seminars, students using teaching material to self-study such as reading a book or watching educational videos, and doing assignments such as writing an essay or answering on a quiz.

## ***1.3 Method and data***

To address the research question, we chose to analyze eleven university courses that had different experiences of implementation of digital teaching materials. Some of the courses had their first implementations of digital teaching materials and were developing their approach while some of them had used digital teaching materials as part of the teaching

repertoire for a few years. We chose a multiple case study to be the research design and selected eleven courses from three universities. Eleven case courses were selected by purposeful sampling from the pool of courses that had implemented digital teaching materials in teaching in a course for limited participants in a Finnish university. All of the case courses were intended for university students with a right to study and take a course in university. This means that observed case courses were not massive open online courses (MOOC) that would have massive scalability and open access. Overall case courses had a variety of educational modalities: contact teaching, blended teaching and distance teaching. The number of digital teaching materials, the use varied in the case courses, and how long digital teaching materials had been used in previous iterations of the courses. Case courses were from Finnish universities. We gathered data from the case courses with a large variety of different observation methods. These data gathering methods were observations from contact teaching, inspecting course materials, conducting student survey, in-depth semi-structured interviews with teaching staff, in-depth semi-structured interviews with students, and participation in course designing.

#### *1.4 Contributions*

We provide new knowledge concerning three distinct research areas of teaching (using digital teaching materials, blended teaching, and flipped classroom). We elaborate connections between these distinct three research areas with our findings. Similarly, our findings concern different aspects of how to use digital teaching materials to support learning. Our first three propositions concern the form of educational videos, how teachers are supported to start using digital teaching materials in the courses, and the benefits of the digital teaching materials. The two following propositions, which we argue that are generalizable for overall teaching, provide new knowledge about the effect of awarding points in grading, and using assignments to motivate people to go through materials. With our sixth proposition, we also discuss the overall view on Finnish university student and their motivation based on the observations of students using digital teaching materials and how to ensure that students use the digital teaching materials. The last two propositions concern the feedback on the digitalized course and the role of active learning. We provide new knowledge to existing research in the section 5 Discussion. We offer the pedagogical implications based on our findings in section 6.2 Pedagogical implications.



## *1.5 Structure*

The remainder of this thesis is laid out as follows. First, we analyze research from pedagogical and educational psychology, we inspect the theoretical background of the use of digital teaching materials in courses, course structures, and students that study in universities in section 2 Theoretical background. After the theoretical background, we go through the 3 Methodology of the study. The methodology covers the 3.1 Research approach, 3.2 Selection of case courses, 3.3 Descriptions of the related organizations of case courses, 3.4 Descriptions of case courses, 3.5 Data gathering, and 3.6 Data analysis. Then we go through the findings of the thesis basing them on the case courses studied in section 4 Findings from the course developments. After findings, we move on to 5 Discussion tying together the findings and compare them to the theoretical basis that was established in the theoretical background. The thesis ends in 6 Conclusions which cover 6.2 Pedagogical implications of the thesis, 6.3 Validity and reliability considerations, and 6.4 Future research avenues.

## 2 Theoretical background

In the theoretical background, we analyze the literatures of educational psychology and pedagogical views about university teaching, and research on digital teaching materials and its use. We argue that learning is the most important aspect that university teaching intends to achieve. Therefore, it is important to know what the understanding is how to teach effectively to achieve impactful learning outcomes. After 2.1 Principles of learning and teaching section, we go through research regarding the use of digital teaching material. We analyze the research directly related to digital teaching materials in section 2.2 Use of digital materials in courses and then we analyze research about 2.3 Blended teaching and use of one particular way of structuring course the flipped classroom in section 2.4 Flipped Classroom. In the last part of the theoretical background, we analyze research about university students and their studying habits in section 2.5 Student diversity in universities.

### 2.1 *Principles of learning and teaching*

This subsection deals with principles of learning and teaching. We argue that the most important aspect of university teaching is to get students to learn. Thus, we analyze research about learning and teaching. The goal is to understand how we should approach teaching and how students learn.

Definitions for learning are varied. Alexander et al. (2009) define learning as follows: “Learning is a multidimensional process that results in a relatively enduring change in a person or persons, and consequently how that person or persons will perceive the world and reciprocally respond to its affordances physically, psychologically, and socially. The process of learning has as its foundation the systemic, dynamic, and interactive relation between the nature of the learner and the object of the learning as ecologically situated in a given time and place as well as over time.”

Brown et al. (1997) offer an alternative and shorter definition of learning. They define learning as “changes and improvements in knowledge, understanding, skills, and outlooks”. Both of the definitions agree that there is a change in knowledge and outlook of a person. Brown et al. offer a more concise version whereas Alexander et al. (2009) take into account that change in outlook should be relatively enduring for it to be learning.

When moving beyond the definition of learning, there are theories of learning. Different learning theories offer differing implications for teaching and they have an effect on research. On a practical level and on the level of individual studies that base their results hypothesis testing for empirical data from one course, the impact of certain learning theories might not be obvious. However, books about organizing education seem to have been impacted by different learning theories that authors themselves subscribe more than individual studies. Because of learning theories, there might be differences between which aspects of learning and teaching are focused when giving pedagogical implications on research papers and books. Schunk (2012) identifies six critical issues in studying learning and different learning theories offer differing views on how learning happens. The critical issues are: How does learning occur, what is the role of memory, what is the role of motivation, how does transfer occur, which processes are involved in self-regulation, and what are the implications for instruction. Schunk (2012) also introduces four different theories. Behaviorism and three cognitive theories: social cognitive theory, information processing theory, and constructivism. Different cognitive theories focus on the formation of mental structures and processing of information but disagree which mental processes are the most important during the learning while behaviorism focuses on the environmental stimuli.

Biggs & Tang (2011) define two types of learning: Surface learning approach and deep learning approach to learning that students use in university courses. The surface approach is doing the minimum effort to successfully meet course requirements. It is memorizing information without understanding the relationship between bits of information or understanding the whole structure behind the information. The deep approach is learning to connect the individual bits of knowledge to a coherent overall structure of information.

Learning is something that happens within students. Teaching is interactive and focused actions that try to improve students learning (Hyppönen & Linden, 2009). Teaching does not directly impact on learning because learning is dependent on students' actions and effort. However, teaching can enhance or hinder students learning. Therefore, teaching processes and methods are important to look at, so students use their time to learn.

Teaching should focus on how students respond to teaching. By looking at student's responses, we can develop teaching to serve the learning process. Biggs & Tang (2011) describe three levels of how teachers view teaching. The first level is to focus on if the

student is a good or bad learner. Transformation of information is constant and learning differences are attributed to differences between students. The first level does not lead to improvements in teaching as problems with learning can be attributed to a student to be a bad learner. The second level focuses on what the teacher does. This model ignores how students respond to teaching. It focuses entirely on the teacher and if students do not learn it is the teachers who should change their behavior. Level three focuses on what the student does. In this view focus in on how the student responds to teaching methods and if these responds guide to intended outcomes in learning.

Based on the prior research teaching methods that promote active learning seem to have better results than traditional teaching (Freeman et al. 2014, Prince 2004). Active learning is a learning process where student processes knowledge and constructs the meanings of information as opposed to passively absorbing the information (Johnson & Johnson 2008). One possible way to have students actively learn is to utilize inductive teaching methods. Prince and Felder (2007) define inductive teaching methods to have students presented a challenge and students need to seek and learn to know how to address the challenge. Examples of inductive teaching methods are inquiring during lecture, cases, and projects. Freeman et al. (2014) conducted a meta-analysis on 225 studies comparing active and traditional learning in science, engineering, and mathematics. They found out that active learning sessions improved scores by 6 % and in traditional classes, students were 1.5 times more likely to fail the class. Their results strongly suggest that active learning measures should be taken as the preferred teaching method.

Even though active learning and inductive teaching methods provide better learning results, students may prefer traditional methods. Prince & Felder (2007) study different inductive teaching and learning methods. How effective they are, how they are implemented and how students respond to them. They give suggestions to practitioners that if instructional objects of the course demand high cognitive levels for targets (e.g. explain, solve, apply to different fields, versus simple memorization) inductive methods should be used. For lower cognitive levels, such as memorization, implementing inductive methods is not needed. They warn that some of the methods might get backlash from students even though they are effective for learning. The hardest inductive methods should be avoided if future employment is depending on the quality of teaching. They also note that inductive methods demand resources and if not available then one should use inductive methods with small resource intensity.

Prevalent model of teaching in universities has traditionally been lecturing. If teachers are not trained in teaching, they default to the prevalent model of teaching (Gibbs & Coffey, 2004). Gibbs & Coffey (2004) studied the impact of pedagogical education of university teachers on their teaching approach. They found out that teacher's training increased adopting a student-centric focus on teaching. As the student-centric focus is seen to be associated with students taking deep learning approaches, which improves learning outcomes, this is a preferred outcome. Teachers are capable to improve their teaching with pedagogical training compared to no training. Possible negative effects of not getting training might be regarding the negative influence of institutions in university regarding teaching. A change would be seen as criticism towards experienced colleagues. Training would be needed as counter-balance against this negative influence from teachers' departments.

## *2.2 Use of digital materials in courses*

This section deals with prior research about using digital teaching materials and their effects on learning. Research has had different focuses on the use of digital materials. Practice-oriented research has focused on individual digital materials for example use of videos or simulations and their learning effect on students (e.g. Zhang et al., 2006, Simo et al., 2010). On the other hand, there is research that derives their suggestions on how to use digital teaching materials from different learning theories (e.g. Karppinen, 2005, Laurillard, 2002).

Educational videos are only one part of complex learning activities that composite learning of a topic and they need to be integrated into other learning tasks (Karppinen, 2005). Karppinen (2005) argues that the learning outcomes overall depend on how videos are integrated into the overall learning environment. As she builds on constructivist view on learning, she argues that videos should fulfill characteristics of learning that constructivist theories have deemed necessary for meaningful learning. Karppinen (2005) chose six characteristics: Active – giving students active role in learning, constructive and individual – students add new ideas to their prior knowledge, collaborative and conversational – learning when building on other students skills together, contextual – learning should be attached to real-world tasks when applicable, guided – learning process with cooperation with teacher, and emotionally involving and motivating – involvement in subject and the medium. Meaningful learning situations should have some these characteristics but not all of these are demanded simultaneously all the time for learning to be meaningful. Karppinen

(2005) gives suggestions on how videos could be used to fulfill these constructivist views on meaningful learning but also emphasizes that integration to the whole learning process is the key thing.

Using different digital teaching materials complements each other to provide balanced and learning focused teaching. Laurillard (2002) suggests multiple media balanced approach to improve university teaching. She subscribes to a learning process that is derived from phenomenographic studies. It focuses on that learning session presents learners new information, shows the learner the connections between critical issues in a new topic, discover learners' misconceptions and correct them, and creating learning situations where learners have to center their attention to critical aspects of topics. Different digital teaching materials and media have individual strengths to fulfill their position in the learning process. Videos and print, for example, are narrative media and are suitable to deliver new information and show the connections between critical issues. Discovering misconceptions and correcting them is achieved via communication between teacher and students in a group, adaptive medias such as simulation and games, and production medias such as assignment. These also provide learning situations where students focus is directed to critical issues in learning a topic. Even though the majority of the student's time is spent self-learning via differing medias the feedback via discussion or through other media is a very important part of the learning process.

Educational videos need to be designed well in order them to be viable course materials (Dong & Goh, 2015, Brame, 2016). Brame (2016) recognizes three elements that are needed for effective video design and implementation: cognitive load, student engagement, and features that promote active learning. Cognitive load is about information transfer from sensory inputs to long term memory. Effective practices for this are Signaling – for example, highlighting important information in videos. Segmenting – dividing information in small chunks, for example, short videos. Weeding – eliminating unnecessary sensory inputs e.g. music. Matching modality – visuals and audio need to convey complementary information. Students can be kept engaged with videos by keeping videos short, directing speech to a student like in conversation, speaking enthusiastic and relatively quickly, and highlighting the connection to the course and relevance to topics. The last element is active learning. Making videos part of an assignment, using guiding questions, and interactivity in videos for example in the form of questions embedded in videos.

Students perceive the use of digital teaching materials as positive for their learning (Tiernan 2013, Simo et al. 2010). Simo et al. (2010) found that short educational videos improved student motivation and student perceived that it improved the learning process. Tiernan (2013) studied the use of videos in lectures and found that videos were an effective tool to spark discussion in the lectures in addition videos offering easily understandable information. Though some students used the time of watching videos in lectures to relax rather than focusing on the video. Student perception depends on the use of digital teaching materials. If they are not used as an integral part of the teaching, the students will not see the benefits. Henderson et al. (2015) found that students mostly cited the benefits of digital technologies as logistical rather than benefits for learning. Henderson relates that students might not see the benefits of digital technologies for learning if they are not presented for them.

Well-made and easy to navigate videos can increase learning and student satisfaction on courses. Zhang et al. (2006) studied the effect of interactive instructional videos on student learning and satisfaction. They found out that in their course context interactive videos had the best results in learning. Non-interactive videos and no videos distance learning had similar results and worst results were with traditional lecturing.

Simulations also improve learning outcomes when integrated as a part of the overall functioning learning environment (Rutten et al. 2012). Rutten et al. (2012) reviewed studies about using simulations in science teaching and found that simulations had a positive effect on learning when replacing or enhancing traditional lectures and using as preparation for laboratory work. Positive effects of the simulations were attributed to the visualization of otherwise unobservable phenomena, discovery learning process, instructions related to simulation, and skill of teacher applying simulations. Similarly, to educational videos, the integration to other learning was important, changing learning to a more active learning style, and the possibility to utilize differing learning approaches with visualization than with traditional approach.

Faculties are divided in the adoption of digital teaching materials. Motivated teachers use digital teaching materials despite resource limitations while those that are predisposed against digital teaching materials avoid them (Lean et al. 2006, Harley 2007). Harley (2007) notes that most of the faculty wish to build their own materials and digital teaching materials should complement the pedagogical approach of the teacher. If materials and approach do

not mesh, then the teachers avoid materials. Lean et al. (2006) find similar results for the use of simulations. Use of simulations in teaching was limited by professional judgment of benefit and risk rather than resources.

Digital teaching materials need to be integrated into course for them to be effective as other teaching materials. Digital teaching materials can fulfill the roles that have been previously occupied with more traditional methods and media such as lecturing, books, and assignments. However digital teaching materials cannot wholly replace all other methods and media in teaching but rather should be used as a replacement where applicable substitute and complementary when other methods are more suitable for the task.

### *2.3 Blended teaching*

We found a large body of research that studies the education approaches, modalities, methods and course structures (e.g. Graham et al., 2013, Piccolo et al., 2001). Digital teaching materials are used in blended teaching and distance teaching courses as an integral part to deliver the contents of the courses to students. Digital teaching materials have enabled change in thinking that most information should be passed through lecturing and research has focused on how to use different course modalities (contact teaching, distance teaching) in related to another.

The definition of blended teaching varies. Literature uses both terms of blended learning and blended teaching. Graham et al. (2013) define a spectrum of course-delivery modality. They range from traditional contact teaching where is no online components to completely online which has no face-to-face components. Between these two points is blended teaching. Graham et al. (2013) though specify three different modalities between two extremes. Technology-enhanced which uses online components but has no reduction in face-to-face time. Blended teaching which has a reduction of face-to-face time. The third is mostly online where there is only supplemental face-to-face time. This Grahams et al. definition looks the face-to-face time in the relation of an online component and defines blended teaching quite strictly. The term blended learning has also had critique as it concerns more teaching than learning and alternative terms such as blended pedagogies have been suggested (Oliver & Trigwell, 2005).

We chose to use term blended teaching in this thesis as a combination of teaching activities that include face-to-face interactions and distance teaching interactions between students,



teacher, and materials (Bliuc et al. 2007). Blended teaching captures the idea that these are methods to organize teaching. Even though, the point is to encourage learning in students the blended teaching is about structuring the teaching and therefore we use term blended teaching. We will not use as a strict division between technology-enhanced, blended teaching and mostly online teaching as Graham et al. (2013) do. As established the other literature may use alternative terms such as blended learning or blended pedagogies for blended teaching.

Virtual learning environments differ from traditional lecture-based teaching. It offers accessibility to teaching in different ways than traditional teaching. Piccoli et al. (2001) studied the effect of transferring studying into a virtual learning environment. They defined six different dimensions for learning environments: time, place, space, technology, interaction, and control. Time concerns when the instructions are delivered. For example, time concerns if the instructions are delivered asynchronously or at a certain time for example in a classroom. Place concerns where the instructions are delivered. Traditionally there has been a need to be located in a classroom but with a virtual environment, learners can be where-ever they can access the internet. Space refers to the collection of materials and resources that students use. Technology is tools that are used to facilitate communication and deliver materials to students. Interaction is contact between learners and instructor and among learners themselves. The last aspect is control, which is how much learners can control the instructions and presentation.

Transferring all teaching to distance teaching does not provide automatically better results than traditional lecturing. Distance teaching is a different teaching approach than students are used to and may hence cause problems. Piccolo et al. (2001) divided their students into two groups. One of the groups would use a traditional classroom environment and another virtual learning environment. Virtual learning environment would allow students to participate in teaching freely in time, location and in their own pace. Their hypothesis was that it would allow better results. Their results were that there was no difference between the groups in test scores. Students were not familiar with the learning environment and were dissatisfied with education through online resources. The virtual learning environment also might cause a feeling of isolation and anxiety for students.

Distance learning needs to be designed well and captivating for students, so student participation is active, and students use a deep approach to learning. Bullen (1998) studied

how participation and critical thinking could be facilitated in distance course over the internet. Bullen (1998) says that online courses need a preparation from the teacher and student part that environment is comfortable to use, and all are prepared. If students are not used to working in a distance course, face-to-face could be used to help the transformation. Distance learning and all online meetups needed to be seen as integral to success in the course otherwise participation was half-hearted.

Rovai & Jordan (2004) discuss the change of paradigm in learning. Paradigm has been shifting from lecture-based learning to encourage critical thinking. They discuss the role of distance learning, sense of community and possibilities and range of blended learning. Rovai & Jordan (2004) studied blended teaching where the online material was used to complement classroom material and students were on master's level courses. They conclude that blended teaching can be used as a good way to reach out students but at the same time, there is a need to build a community within a course for teaching to be more effective.

## *2.4 Flipped Classroom*

One specific a lot researched way to organize teaching has been flipped classroom. Flipped classroom concerns where the information transfer and exploration of information should take place. Traditionally teaching has been information transfer heavy and the information transfer happens mostly during the contact teaching. In the traditional model, lectures could have for example first pre-reading (information transfer) and then lecture (information transfer) though lecture might contain some discussion (information transfer or exploration depending on the topic of discussion) making overall contact teaching information transfer heavy. Cases, group works, learning diaries and after-lecture assignments (explorative) have been mostly done outside of a classroom. The flipped classroom approach changes the idea so that information transfer would be done first and outside contact teaching (videos, pre-readings) and exploration and feedback would take place in the classroom (e.g. Bishop & Verleger, 2013, Herreid & Schiller 2013). Flipped classroom differs from distance learning in a way that it includes in-class active learning part in addition to video lectures as opposed to distance learning which only features video lectures and tests done individually (Bishop & Verleger 2013).

The flipped classroom has the potential of changing teaching to more student-centric variety and increase critical thinking capacity in the students. However, achieving these objectives

demand that teaching staff understands how to fully use the possibilities that the flipped classroom can offer (Flaherty & Phillips, 2015). Flaherty and Phillips (2015) did a systematic review of flipped classroom studies. Their material consisted of 28 flipped classroom studies. Their material consisted of higher education use of the flipped classroom and courses were taught in English. Most of the studies analyzed in the systematic review were cases of a single flipped course. Even though most they had positive results in them, the studies mainly measured secondary attributes related to learning such as student satisfaction as opposed to directly measuring learning. Five studies measured improved student examination results. Studies that would inspect flipping of whole study programs and measuring higher learning improvements were not yet sufficiently studied according to Flaherty and Phillips (2015).

Most of the studies on the flipped classroom are based on case studies. Results have been positive but hard to generalize. Bishop and Verleger (2013) summarize results of case studies that have been done on the flipped classroom. They report that most of the studies have been single cases and based on students' perceptions. Single cases would point out that students learn better in a flipped classroom approach than in the traditional model. Students' reactions to model according to study is mixed but generally positive. Bishop and Verleger argue that even though single cases are encouraging they are not enough for generalization. An example of a successful case is provided by N.T.T Thai et al. (2017). They studied the impact of the flipped classroom and they compared it to blended teaching, traditional contact teaching and distance teaching on the second-year students in a Vietnamese university. Their study concluded that the flipped classroom had the best results of tested four different methods. Another encouraging study is by Bazalais & Doleck (2018) who studied the impact of the flipped classroom in the first-year physics course. They described their approach as blended teaching, but the method was similar to other studies that use flipped classroom as the name of the method. They used for blended teaching group video lectures and contact teaching was not reduced but mainly focused on solving real-world physics problems. Small time was used for discussing video lecture content before tackling problems if needed. They had a control group using the traditional method with 80 min lectures. Students answered that they preferred peer learning to lectures and had a positive experience with blended teaching/flipped classroom. Using blended teaching students also had better test results.

Students need to prepare for explorative contact teaching for it to be effective. Herreid and Schiller (2013) identified two problems with flipped classroom and student behavior.

Students would be unprepared for active learning part. This could be solved with a short quiz online or in class or by homework that would require information in the videos (e.g. short essay). Another is that pre-readings and videos need to be tailored for students that they would be ready for in-class activities. Lack of suitable videos would be limiting to usability as preparing the material. Herreid and Schiller (2013) emphasize that active learning is better than passive and flipped classroom is only one way to utilize active learning in their conclusions.

The flipped classroom can be scaled to large classes. Finne (2018) looks in his study improving an operation management basic course at Warwick University by using a flipped classroom and approached the improvement process from a professional service operations perspective. The course was large with typically over 300 students and in this case 375. In this case, the flipped classroom received good feedback from students. The course was organized as follows. Students were provided with video lectures and pre-readings. There were biweekly online tests to ensure that students studied the materials. Lectures were explorative in nature rather than information transferring as most of the studying was done beforehand with videos and other material. Lectures focused on analysis, application, questions, feedback, and discussion.

Students and teachers need time to adapt to new teaching methods. Traditional teaching methods are very prevalent and adapting to alternative methods takes time that teachers and students accept their effectiveness. Roehl et al. (2013) stress the importance of allowing students to adapt to the flipped classroom. They also highlight possibilities of developing critical thinking, creativity, communication, and collaboration as these are actively encouraged in contact learning. Flipped classroom demands a different mindset for students and teachers alike. The study sees flipped classroom and active teaching methods the better way to engage millennial students which might have a lower tolerance for passive listening.

The flipped classroom is one way to employ active learning. Changing explanative and explorative activities location itself do not provide better results. Jensen et al. (2015) argue that the flipped classroom does not result in better learning outcomes when compared to the traditional model with active components. They state that most of the studies regarding flipped classroom do not take into account that the flipped classroom model changes learning to more like active learning than the traditional model. They conducted a study that compared flipped classroom to traditional model when both had active elements. They found

out that both the flipped classroom class and the traditional active class had comparable results.

## *2.5 Student diversity in universities*

Students in universities are a diverse group of people and should not be treated as singular mass. Some of the students are more academically inclined and interested in learning than others. Biggs (1999) divides university students into two groups and uses two example students to illustrate his point. An academically minded student “Susan” who uses higher-order learning processes such as getting relevant background knowledge and formulates questions about information beforehand lecture. During the lecture, she gets her questions answered and constructs a body of knowledge. Afterwards she reflects what she has learned. She would probably learn even without teaching. Another student type is “Robert” who is less inclined to use these deep learning methods automatically. He might be motivated to attend university because of getting a diploma enables him to get a better job. His participation in lectures is limited to note taking and hoping that he will get enough information to pass the exam. Biggs describes “Susan” utilizing the deep approach to learning and “Robert” having the surface approach to learning.

By utilizing activating teaching methods teachers can also engage less academically minded individuals. Biggs (1999) proposes that one cannot close the gap between the two types of students but with active teaching methods the gap can be made smaller. Active teaching methods make “Robert” learn more like “Susan” according to Biggs. In addition, active methods help “Susan” to realize her potential better. So, with active methods, such as problem-based learning, not only “Robert” get better results and closer to “Susan”, but she also gets better results.

The Finnish university system has differences compared to Anglo-Saxon universities. Education is free for students as opposed to Anglo-Saxon countries where there is a hefty fee for each semester. Academic freedom might also be viewed differently also (Vauhkonen, 2012). In Finland, student interest groups view academic freedom and responsibility more broadly than in Anglo-Saxon countries that students should be able to choose courses and methods of learning that they employ (Vauhkonen, 2012). In other countries, academic freedom is viewed as more of a property of faculty that they should not be prosecuted for their pursuits of knowledge (Altbach, 2001, Macfarlane, 2012).

Student diversity can be also found in Finnish universities. According to Lukkarinen et al. (2016), there are different types of students in universities. In one course in a Finnish university, 50 % did not attend exams and failed the course. The second group of 34 % attended the contact teaching (lectures and exercise sessions) and an exam and passed. The third group 16 % of the students had low attendance but passed an exam well. They showed capability for self-study. Reasons for opting to self-study were varied but justified such as work and other courses.

Finnish university teachers have a clear idea of which is an ideal academical student (Kangasniemi & Murtonen, 2017). The question remains how universities should support students to become this self-managing ideal and which percentage is capable to achieve this ideal. How many are “Susans” as Biggs (1999) illustrate and how many are “Roberts”. Kangasniemi & Murtonen (2017) listed views of university personnel on skills that a responsible university student has. According to them the university personnel view that responsible student is critical, motivated, interested, active, responsible and capable of scheduling own studies. They say that this view of the responsible student is in accordance with modern pedagogical theories and supports universities view of the responsible self-managing student.

New Finnish students have indicated that too much academic freedom and not enough support from structures hinder their studying (Pajarre, 2012). Pajarre (2012) studied first-year engineering students at Tampere Technical University and their views on studying. According to Pajarre (2012), many starting students felt that academic freedom was challenging. One of the most indicated weakness of students studying process was starting too late to study for an exam or late start for making exercises.

Competence levels of students also vary. Veerasamy et al. (2018) studied the effect of previous programming knowledge to lecture attendance and exam performance. They had an indication that prior programming knowledge had a positive effect on passing an exam but a negative effect on lecture attendance. Lecture attendance effect on the passing exam had mixed conclusions.

These examples indicate that there is variance in students of the university. Some of the students have more prior knowledge than others. Some of the students are not capable to attend contact teaching for a reason or another. Ability to attend contact learning sessions

with different approaches to learning e.g. surface and deep learning means that universities face a challenge to teach a diverse group of students.

## *2.6 Central concepts and logics connected to teaching for the empirical study*

Research presented in the theoretical background chapter forms the research position on analyzing the use of digital teaching materials in the courses and how courses should be structured for effective learning. Sections 2.2 Use of digital materials in courses, 2.3 Blended teaching, and 2.4 Flipped Classroom form the research that we seek to elaborate with the empirical material. Sections 2.1 Principles of learning and teaching and 2.5 Student diversity in universities provide additional context of the teaching in higher education.

Central concepts in the empirical study are the following: A first central concept is a learning event which we use to represent singular tasks that students participate and do during the course. Examples of learning events are attending to a lecture, watching a video, doing a learning diary chapter, and having a group work meeting. We use a learning event as a catch-all term to describe the myriad of different information transfer and exploration teaching methods and singular events that are possible in courses.

Second important concept is different course modalities. Contact teaching, blended teaching, and distance teaching are different modalities that were present in case courses. Different modalities need different approaches when organizing teaching and have their own benefits and challenges which impact to course design. For example, distance teaching can be location and time independent but needs special attention to engage student because of little personal contact. The last central concept is active learning which is a method that “engages the student in the learning process” (Prince, 2004) as opposed to passive learning where student more or less is observant and not actively engaged in the process.

## **3 Methodology**

### *3.1 Research approach*

The purpose of the thesis is to address the question of how digital teaching materials can be used to support learning in higher education. In order to address that question, we engaged in theory elaboration (Ketokivi & Choi, 2014) to elaborate theoretical knowledge on how to use digital teaching materials to support learning. Our findings concern broader knowledge regarding students' learning, pedagogical approaches, educational modalities, and course structures. We seek to elaborate the practice-oriented research about teaching, learning and the use of digital teaching materials to support learning, which we established in 2 Theoretical background chapter.

We chose multiple case study as our research method for this study. We examine eleven courses that applied digital teaching materials in teaching. By analyzing eleven case courses we got an overview of the environment where courses are taught. By examining case courses, we could identify differences and similarities between the cases. From this cross-case analysis, we could derive convergent patterns and statements that would allow us to compare findings to literature and elaborate on the current understanding of the use of digital teaching materials.

The overall process of this research follows a slightly modified case study process. We started the case process by identifying the research question. Then we conducted a review of prior research. We did the selection of cases and data gathering phases in parallel. We described these parts in more detail in 3.2 Selection of case courses and 3.5 Data gathering sections. After this part of the process, we analyzed the data within the case and did the cross-case analysis which is covered in more detail in the 3.6 Data analysis section. This led to shaping the findings which were compared with the literature.

### *3.2 Selection of case courses*

We selected 11 courses to be our sample. In this study, we study the case courses and their inherent development process of using digital teaching materials. We chose case courses that were in different development stages in terms of their use of such materials: videos, simulations, quizzes, and etc. Some of the courses had used digital teaching materials for years and some courses had their first implementations of digital teaching materials in their



courses during the study. We analyzed case courses and their development subsequently in the study. The process went as follows. We used purposeful sampling (Palinkas et al. 2015) to identify case courses that utilized digitalized teaching materials in different ways. From the all possible courses, we chose eleven case courses that were different in terms of use of digital teaching materials and course delivery modalities (contact, blended or distance teaching). However, case courses were similar in terms of being selected from the Finnish DIEM context. Quite many of the courses were courses in the field of project business which introduced a subject area of digital teaching materials in course contents that was common among the professors and teachers in different Finnish universities providing these case courses. These professors and teachers also provided FITech-funded courses in the field of Project Business jointly.

We observed three of the case courses through the author being part of designing courses and that provided rich observations during the implementation of case courses. By being participant-observer in the design process allowed us first-hand access to a rich body of data that was accessed in other cases via interviews and other data gathering methods. All eleven case courses contributed to getting a rich and varying view of the use of digital teaching materials.

Table 1 includes the case courses. There are the names of the course cases that were selected for analysis. Abbreviation column tells the abbreviation that is used to refer the course in study. The university column indicates in which university the case courses were taught. Course implementation date column indicates when the courses were implemented. Finally, the data gathering methods column indicates the different data gathering methods used to gather information about the course.

Table 1 Case courses in the thesis and basic information about courses

Case Course	Abbreviation	University	Course implementation date	Digital teaching materials	Course delivery modality	Data gathering methods
Advanced Project Based Management	DIEM Adv Proj 2018	Aalto University/ FITech	Fall 2018	Lecture videos, research articles	Contact/ Distance	Observations, data analytics, course feedback, course materials
Project Business	DIEM Proj Bus 2019	Aalto University	Spring 2019	Pre-material videos, research articles	Contact	Observations, participation in course design, data analytics, course feedback, course materials

Introduction to Project Management	DIEM Proj Intro 2019	Aalto University	Spring 2019	Content videos, quizzes, assignments, reading material	Blended	Participation in course design, course materials
Introduction to Project Management	Oulu Proj Intro 2018	Oulu University	Fall 2018	Content videos, quizzes, assignments	Distance	Course staff interviews, course feedback, educational videos as part of the material
Project Management	FITech Proj Man 2019	FITech	Spring 2019	Content videos, quizzes, assignments	Distance	Course staff interviews, data analytics, access to student portal, course feedback, course materials
Summer Boost: Technology and Business Models of Autonomous Ships	FITech Marine Boost 2018	FITech	Summer 2018	Research articles	Distance	Course staff interview
Principles of Naval Architecture	FITech Naval Arch 2018	FITech	Fall 2018	Lecture slideshows, research articles, assignments	Distance	Course staff interview, course materials
Introduction to the Digital Business and Venturing	EIT Digital Bus Intro 2018	Aalto University/ EIT Digital	Fall 2018	Content videos, quizzes	Blended	Course staff interview, survey, student interviews, access to student portal
Digital Business Management	EIT Digital Bus Man 2018	Aalto University/ EIT Digital	Fall 2018	Content videos, quizzes	Blended	Course staff interview, survey, student interviews, access to student portal
Process Analysis and Management	Bus Process Analysis Man 2018	Aalto University	Fall 2018	Simulations	Contact	Course staff interview, course materials
Design in Engineering	ELEC Des in Eng 2018	Aalto University	Fall 2018	Method animations, designer interview videos	Contact	Course staff interview, course materials

### 3.3 Descriptions of the related organizations of case courses

In this section, we introduce case courses in more detail we also introduce five organizations that were responsible for running the case courses: Aalto University, DIEM, EIT Digital, FITech and Oulu University and one support organization A!OLE that supported the production of digital teaching materials in Aalto University.

## *Aalto University*

Aalto University is a Finnish multidisciplinary university that comprises six schools. Four technology schools, school of business, and school of arts, design, and architecture. In 2018 there were 5500 bachelor's and 5300 master's degree students at Aalto University. The vast majority of bachelor's students were Finnish. A quarter of master's students were international.

## *Department of Industrial Engineering and Management*

Department of Industrial Engineering and Management (DIEM) in Aalto University offers teaching in one bachelor's major program Industrial Engineering and Management, and three master's level major programs Operations and Service Management, Strategy and Venturing, and Organization Design and Leadership. Department takes approximately 50 students in each year for combined bachelor's and master's program. DIEM also offers a minor program for Industrial Engineering and Management for whole Aalto University. Students in DIEM courses were mainly degree students from Aalto University.

## *Aalto Online Learning (A!OLE)*

A!OLE is a program within Aalto University that helps and supports teachers to develop new technical solutions and pedagogical models for blended teaching. A!OLE organizes workshops, events, provides a place for like-minded teachers to network. One main way to promote new teaching methods is to foster pilots where A!OLE provides resources and training for pilots that intend to develop digital teaching in courses. In addition to pilots, the A!OLE provides support for video production, VR production, and visual materials. Annually A!OLE funds around 50 pilot projects.

## *EIT Digital*

EIT Digital is a European program that offers education about digital innovation and entrepreneurship. It has ten nodes in Europe Brussels, Berlin, Budapest, Eindhoven, Helsinki, Madrid, London, Paris, Stockholm, and Trento that combine local universities and businesses together into EIT Digital organization. The master's program offered in EIT Digital was a two-year program where students spent one year in one of the universities participating in the network and change university for the second year. As a pan-European program where students change university during the program, there is a need for

harmonizing the teaching which is solved with a platform that contains digital modules about topics that every student should learn about digital innovation.

Case courses were from minor in EIT Digital Program called Innovation and Entrepreneurship (I&E) taught in Helsinki Node Aalto University. Minor offers a program about Innovation and Entrepreneurship for students that study deeply technical major to offer them a practical side of business and entrepreneurship, in addition, the technical major. I&E shares a lot of courses with Aalto Ventures program that provides entrepreneurship education for Aalto students. Case courses had students both from the EIT program and Aalto University.

### *Finnish Institute of Technology – FITech*

The Finnish Institute of Technology (FITech) was a network university that was founded in 2017. The original aim of the FITech was to provide a competent workforce to the companies of South-Western Finland with FITech Turku project. In 2019 FITech got new project ICT where the aim was to provide supplementary education to ICT professionals. FITech consisted of all of the seven technical universities in Finland. The seven universities worked together to provide the engineering education to South-Western Finland which lacked its own departments in certain fields such as project management and marine technologies. Students in the FITech were mainly from seven technical universities participating in FITech though in addition there were people from industries to update their knowledge.

### *Oulu University*

Oulu University is a science university located in the City of Oulu in Finland. It has 13 500 students in eight different faculties. Oulu University has faculties of Biochemistry, Education, Humanities, IT and Electrical Engineering, Medicine, Science, Business School, and Technology. One of the fields where the Faculty of Technology operates in is the field of Industrial Engineering and Management.

## **3.4 Descriptions of case courses**

### *Advanced Project-based Management – DIEM Adv Proj 2018*

DIEM Adv Proj 2018 was a master's level course that was taught in DIEM Operations and Service Management program and mandatory for students that were majoring in that

program and elective for those minoring in the program. The course dealt on how to apply different project management method in differing project environments. There were approximately 50 enrolled students of which 30 chose to complete the empirical assignment. The course was taught in fall 2018. The course had retained its form for a couple of years though it was running in fall 2018 simultaneously in FITech for students in Turku. Main teaching events were the lectures. These were supplemented with cases done in groups and pre-readings related to cases which would prepare the students for the topic of the lecture. The course had an empirical assignment for students that chose to deepen their knowledge in project management intended mainly for students majoring in Operations and Service Management. Digital elements in the course were the lecture videos for Turku students and cases and pre-materials were offered in electronic form. Grade constituted from four cases done in groups, exam and empirical assignment for the students that chose to do the assignment.

#### *Project Business – DIEM Proj Bus 2019*

DIEM Proj Bus 2019 was a master's level course that was taught in DIEM Operations and Service Management program and voluntary for students that were majoring in that program and elective for those that had minor in the program. The course dealt with how to manage project business. There were approximately 30 enrolled students of which 9 chose to complete the group assignment. The course was taught in the spring of 2019. The course had retained its form from a previous year. Main teaching events were the lectures. These were supplemented with pre-readings and videos to be watched prior to the lecture which would prepare the students for the topic of the lecture. The course had a group assignment for students that chose to deepen their knowledge in project business, and it was intended mainly for students majoring in Operations and Service Management. Digital elements in the course were the pre-materials were offered in electronic form. Grade constituted from eight learning diaries that students would peer-review, reflection essay and group assignment for students that chose the larger version of the course.

#### *Introduction to Project Management – DIEM Proj Intro 2019*

DIEM Proj Intro 2019 was a bachelor's level course that was taught in DIEM bachelor's program and was mandatory for students majoring in Industrial Engineering and Management and elective for those minoring in the program. The course introduced the

project management methods to students. There were approximately 160 enrolled students. The course was taught in the spring of 2019. The course was changed from previous years for this implementation to utilize blended teaching. The number of lectures was decreased and changed to be more dialogical and introductory about project management and its practices which would be deepened with videos going into project management topics in more detail. Main teaching events were the lectures. Lectures were complemented with videos about project management practices. Videos were divided into eight weeks and each week had small multiple-choice test attached to them which was voluntary to complete but affected to grading. In addition, there were three assignments which students worked in groups. Digital elements were videos and multiple-choice tests. Grade constituted from the tests, assignments and an exam.

### *Introduction to Project Management – Oulu Proj Intro 2018*

Oulu Proj Intro 2018 was a bachelor's level course that was taught at Oulu University in the fall of 2018. There were approximately 150 students participating in the course. The course introduced the project management methods to students. The course had few contact teaching sessions at the start and the end of the course but otherwise, the course was a distance learning course. The main material was a book of project management and educational videos which were complemented with multiple choice quizzes and weekly assignments. Grade constituted from multiple choice quizzes, weekly assignments, and certification exam which provided IPMA certificate. Those that wished could choose reflection essay instead of the certification exam. The course was transformed to be distance learning focused 2015 onwards. Educational videos of that were used in the course had multiple iterations of development during the years with the latest set done in 2017.

### *Project Management – FITech Proj Man 2019*

FITech Proj Man 2019 was a master's level project management course taught in FITech in spring 2019. There were approximately 40 participants in the course. Course structure and contents were similar to Oulu Proj Intro 2018 and it shared the same educational videos as the DIEM Proj Intro 2019 though FITech Proj Man 2019 was a master level course because FITech only offered minor programs for master level students and Oulu and DIEM were also taught bachelor's level program. There were contact teaching lessons during the start and the end of the course. Main materials were the educational videos and the same book

about project management. These were supplemented with multiple choice quizzes about themes in the videos and weekly assignments done individually. Grading was based on the multiple-choice quizzes, weekly assignments, and a take-home exam.

***Summer Boost: Technology and Business Models of Autonomous Ships – FITech Marine Boost 2018***

FITech Marine Boost 2018 was a master's level course about naval architecture and marine industry taught in FITech over summer 2018. There were approximately 20 students in the course. The course had a few lectures during the May of the 2018 but rest of the summer distance learning. The learning contents were from Aalto University marine courses but the implementation of the summer course in FITech was the first time in a particular form of teaching and organizing the course. The main learning events were the lectures at the start of the course, learning diaries during the summer and extensive project work done in groups. Digital elements were electronic scientific articles and use of communication via digital platforms to facilitate learning. Grading was done based on the learning diaries and the project work.

***Principles of Naval Architecture – FITech Naval Arch 2018***

FITech Naval Arch Fall 2018 was a master's level course about naval architecture taught in FITech in fall 2018. It had approximately 12 students participating. Course contents were similar as in similar course in Aalto University but the implementation in distance learning in FITech was new. It had also different teacher responsible for teaching than in the FITech Marine Boost 2018 even though the content was similar. Main learning events during the course were lectures that were delivered in the form of extensive lecture slides offering a broad view on topics in naval architecture and not delivered in contact teaching. Supplementing these were scientific articles offering more detailed views on specific issues. Grading was based on project work and exam at the end of the course.

***Introduction to the Digital Business and Venturing – EIT Digital Bus Intro 2018***

EIT Digital Bus Intro 2018 was a master's level course about digital business and venturing taught in fall 2018. It was the first course of the minor. It had approximately 60 students participating. The main learning events during the course were lectures that were complemented with an online module about digital transformation. The module contained

educational videos and multiple-choice quizzes attached to them. Students also had to complete individual assignments and group assignments. Grading was based on the individual and group assignments and the multiple-choice quizzes in the module.

### *Digital Business Management – EIT Digital Bus Man 2018*

EIT Digital Bus Man 2018 was a master's level course that continued on the minor on I&E taught in fall 2018. It built on the foundation about digital business and venturing taught in EIT Digital Bus Intro 2018. It had approximately 60 students participating. The course was similarly structured as the EIT Digital Bus Intro 2018. Main learning events were the lectures which were complemented with five digital modules about various topics such as IPR and patent laws, and Business ethics and sustainability. Modules contained educational videos, multiple choice quizzes, articles and depending on the module links to additional materials. In addition, the course featured individual assignments and larger group work where students analyzed what happened to Nokia phones division. Grading was based on the assignments and the modules.

### *Process Analysis and Management – Bus Process Analysis & Man 2018*

Bus Process Analysis & Man 2018 was a bachelor's level course at Aalto University Business school taught in fall 2018. It dealt with the subject of operation management. It had approximately 40 students. It had received a new responsible teacher who developed the course to their liking. The main learning events were lectures which contained case presentations done by groups, lecturing, and simulations done in groups during the lecture. Digital elements in the course were the simulations which dealt with various operation management challenges. Grading was based on the group cases, simulations that students did in groups, and exam.

### *Design in Engineering – Elec Des in Eng 2018*

Elec Des in Eng 2018 was a bachelor's level course at Aalto University School of Electrical Engineering taught in fall 2018. It dealt with the subject of designing and engineering teaching methods of designing. It had approximately 15 students. The learning events consisted of the lectures which were supplemented by a series of educational videos about experiences of designers and specific design method animations. Students were required to keep learning diary about their learning process. The course also featured project work about



designing a prototype that was done in groups. Grading was based on lecture attendance, learning diaries, project work process and outcome.

### 3.5 Data gathering

We used a large variety of data gathering methods to get an overview of the state of education in the university courses and how digital teaching materials can be used effectively in university teaching.

Table 2 contains information of data sources we used in the thesis. Data gathering methods in this study were observations in the lectures, participation in the course design process, in-depth semi-structured interviews with key informants, reading and watching course materials from student portals, surveys and feedback forms to students, and in-depth semi-structured interviews with student.

Table 2 Data sources in the thesis

Data source	Information about data source
Participation-observation in A!OLE educational video production	Production of scripts to video production. Interviews with company representative who was recorded. One week intensive Aalto University and A!OLE organized pedagogical and video production -training program.
Participation-observation in course design meetings	Overall 13 meetings. 3 course planning meetings in DIEM Proj Bus 2019 and 5 DIEM Proj Intro 2019. 2 FITech program meetings. 3 Meetings about Project Business courses in FITech.
In-depth semi-structured interviews	10 interviews, 7 with teaching staff, 1 with project manager in FITech, and 2 with students.
Lecture observations with field notes	Participation in 20 lectures. 13 observations from case courses and 7 observations about general contact teaching.
Survey about EIT Digital courses and use of digital teaching materials in the courses	Survey with 27 responders out of 87 students that participated in the two courses. 16 multiple choice questions, 15 statement questions with Likert-scale, and 11 open questions.
Course feedbacks	Course feedbacks from DIEM Adv Proj Man 2018, DIEM Proj Bus 2019, Oulu Proj Intro 2018, and FITech Proj Man 2019.
Student portal (MyCourses, Moodle) information and teaching materials (videos, lecture slides)	Educational videos from DIEM Adv Proj Man 2018 (Eight lecture videos), DIEM Proj Bus 2019 (12 videos), Oulu Proj Intro 2018 (36 videos), and FITech Proj Man 2019/DIEM Proj Intro 2019 (50 videos) which shared the materials. Lectures slides from the case courses that contained information about organization, grading, course curriculum, and materials.
Course participation data, video watch statistics	Analytics from the video watching from the DIEM Adv Proj Man 2018, DIEM Proj Bus 2019, FITech Proj Man 2019. Student participation details from DIEM Proj Bus 2019 and DIEM Proj Intro 2019.

During the research process, the author participated in the digital teaching material production in the form of Aalto Online Learning (A!OLE) pilot Reach-out project videos. In this project, we participated in the production of video content that would be used in master level courses as studying material. The production included scripting, planning the interviews, preparing with the interviewee, and shooting material. Working in the A!OLE pilot also allowed access to workshops about video production, teaching, and community of teachers that are interested in digitalized teaching.

Table 3 contains the explicit material that was produced during the pilot and used as material for this thesis. Two interviews and record from the filming day were transcribed. The video recording of the pilot went as follows. First preliminary interview at Neste that was to confirm the interest to participate in the pilot and discussion that everyone was informed about the overall picture. After confirming in person that Neste was committed to the pilot the scripting of the videos began. We produced preliminary versions of manuscripts that were used in the second interview. The second interview was a dry run to see what the interviewee would talk about when posed the interview questions. After the interview, the scripts were revised. During the recording day, eight interviews were recorded.

During the pilot, we participated in a week-long workshop about video production and overall pedagogy workshop. The workshop had the first and the last day of the workshop when the whole course was participating and developing own courses with the support of peers and teaching staff. Rest of the time we participated in lectures that concerned the video production with topics of scripting the video and presentation and chance to shoot small trial. Rest of the sessions during the week concerned different pedagogical approaches, tools that could be used in teaching and practicalities that concern teaching such as legal aspects of having project work with a company.

Table 3 A!OLE Pilot Reach-out Project Videos materials

Reach-out videos	Description	Date	Length
Interview	Interviewing director at Neste	23/08/18	59 min
Interview	Interviewing director at Neste	02/10/18	121 min
Record from filming day	Record of directions when camera was not recording	01/11/18	50 min
Manuscripts	9 manuscripts for interviews		
Neste NEXBTL interview series	8 interviews in video format		67 min

The author participated in thirteen different course and program development meetings. Table 4 contains information about the group discussions that were used as material for the thesis. The meetings concerned the FITech both from Project Business -minor aspect and FITech in Aalto overall. We also participated in two DIEM courses course implementation design DIEM Proj Bus 2019 and DIEM Proj Intro 2019. Meetings had the teaching personnel of the courses participating. The meetings concerned the practicalities and the organizational choices of the courses. Links to Neste NEXBTL interview series are in Appendix C: Links to public educational videos used as sources.

Table 4 Group discussions about course developments and FITech development

Group Discussions/ course planning	FITech PB courses	Date	Theme	Length
Group Discussion (FITech PB)	Seven participants	23/10/18	Basic project course experiences and feedback	145 min
Group Discussion (FITech PB)	Nine participants	09/11/18	Advanced project business courses (APM and PB) redesign. Basic principles and themes.	101 min
Group Discussion (FITech)	18 participants	22/11/18	FITech in Aalto meeting between participating teachers in Aalto and FITech management	113 min
DIEM Proj Bus 2019 design meeting	Four participants	29/11/18	Project Business course implementation	Approx. 2h
DIEM Proj Bus 2019 design meeting	Four participants	10/12/18	Project Business course implementation	Approx. 1.5 h
DIEM Proj Bus 2019 design meeting	Four participants	17/12/18	Project Business course implementation	Approx. 1.5 h
Group Discussion (FITech PB)	Eight participants	19/12/18	Advanced project business courses (APM and PB) designing	120 min
DIEM Proj Intro 2019 design meeting	Five participants	28/01/19	Introduction to Project Management basic course designing	93 min
DIEM Proj Intro 2019 design meeting	Four participants	04/02/19	Introduction to Project Management basic course designing	73 min
FITech Proj Man/DIEM Adv Proj 2018	Three participants	06/02/19	Discussion about good practices to engage life-long learners and experiences in FITech Proj Man and DIEM Adv Proj 2018 for FITech organization	78 min
DIEM Proj Intro 2019 design meeting	Four participants	12/02/19	Introduction to Project Management basic course designing	50 min
DIEM Proj Intro 2019 design meeting	Four participants	21/02/19	Introduction to Project Management basic course designing	112 min
DIEM Proj Intro 2019 design meeting	Four participants	27/02/19	Introduction to Project Management basic course designing	Approx. 1.5 h

In total, we had 10 interviews during this study. Seven interviews were with teaching personnel, one with an administrative person and two with students. We have conducted 7

interviews with teachers of different technical universities in Finland. These were done to gather views on course structure and experiences on digitalized teaching. Each of the interviewees had some experience of courses that had different digitalized materials as part of the courses. However, there were no strict requirements of which kinds of digitalized materials were used in the courses. One of the interviews was with a project leader of the FITech-Turku project to gain knowledge about experiences and challenges of whole network university.

Interviews were semi-structured. The rationale behind semi-structured interviews was to get information about the topic but not to chain discussion too tightly. Interviewees were given topic in advance but not required to prepare for interviews. Interview structures that were used are in Appendix B: Teacher Interview Structure. However, as the interviews were semi-structured if interviewee said something interesting that was pursued rather than continue following rigid interview structure.

Interviews about the case course were supplemented by information about the course structure, grading, assignments, and other practical arrangements from course lecture slides and information in universities online course platforms such as Moodle and MyCourses. We used this information to supplement the view of how courses were practically organized.

In Table 5 are the interviews of teaching personnel and students that were conducted for this study. Table detail the date (format dd/mm/yy) of the interview, title of the interviewee, role of the interviewee in the case course and the length of the interview:

Table 5 Interviews in the thesis

Case course/Organization	Date	Title	Role	Length
Oulu Proj Intro 2018	08/10/18	Associate Professor	Teacher in Project Business courses	94 min
Oulu Proj Intro 2018	11/10/18	Professor	Teacher in Project Business courses	70 min
FITech Proj Man 2019	23/10/18	Doctoral Candidate	Teacher in Project Business courses	30 min
EIT Digital Bus Intro 2018/EIT Digital Bus Man 2018	02/11/18	I&E Coordinator	Teacher in Aalto & EIT Digital	167 min
Bus Process Analysis Man 2018	23/11/18	Assistant Professor	Teacher in Aalto School of Business	93 min
FITech Marine Boost 2018/FITech Naval Arch 2018	26/11/18	Associate Professor	Teacher in School of Engineering	87 min
FITech	03/12/18	COO / Project Director	Project Director of FITech	82 min

ELEC Des in Eng 2018	10/12/18	Senior University Lecturer	Teacher in Aalto ELEC	89 min
EIT Digital Bus Intro 2018/EIT Digital Bus Man 2018	24/01/19	Master Student	Entry year student in EIT Digital	120 min
EIT Digital Bus Intro 2018/EIT Digital Bus Man 2018	28/01/19	Master Student	Entry year student in EIT Digital	84 min

During the study, we observed and made field notes of current contact teaching in Industrial Engineering and Management master level courses in Aalto University. During contact teaching, we observed the number of participants, how content was delivered and how students acted during contact teaching. Seven observations were from DIEM Adv Proj 2018 and five from DIEM Proj Bus 2019 and one from EIT Digital Bus Man 2018. Those observations were from case courses. Seven of the observed contact teaching sessions we participated were not part of the case courses, but they were part of the DIEM master programs. We observed the courses and contact teaching to get an overview of the state of teaching in DIEM. The focus on the observed courses was on the Operations and Service Management major, but some teaching events were chosen from Strategy and Venturing master program. Table 6 contains all the contact teaching sessions that we participated as observant during the thesis process.

Table 6 Observed contact teaching sessions

Contact teaching session	Date	Format	Length
Advanced Project Based Management 1	13/09/18	Lecture/Lecture Video	4h
Advanced Project Based Management 2	20/09/18	Lecture/Lecture Video	4h
Advanced Project Based Management 3	27/09/18	Lecture/Lecture Video	4h
Advanced Project Based Management 4	04/10/18	Lecture/Lecture Video	4h
Advanced Project Based Management 5	11/10/18	Lecture/Lecture Video	4h
Advanced Strategy Case Seminar	17/10/18	Case Seminar	75 min
Management of External Resources	17/10/18	Lecture	3h
Advanced Project Based Management 6	18/10/18	Lecture/Lecture Video	3h
Management of Networked Business Process	19/10/18	Process Interview	3,5h
Advanced Project Based Management 7	01/11/18	Guidance Session	1h
Advanced Operations Management	05/11/18	Exercise session + Lecture	3h
Teaching Demonstration	06/11/18	Lecture demonstration	30 min
Teaching Demonstration	07/11/18	Lecture demonstration	30 min
Strategy Process	23/11/18	Lecture	3h
EIT Digital Business Management	29/11/18	Lecture	2h
Project Business 1	09/01/19	Lecture	3h
Project Business 3	23/01/19	Lecture	3h

Project Business 4	30/01/19	Lecture	3h
Project Business 5	06/02/19	Lecture	3h
Project Business 6	13/02/19	Lecture	3h

We also conducted a survey among the EIT Digital students and Aalto students that participated in the courses Introduction to Digital Business and Venturing and Digital Business Management. The survey was sent to 42 EIT Digital students and to 45 Aalto students. Survey had 25 responds from the EIT Digital students and 2 responses from the Aalto students.

Survey had 42 total questions. Survey had 16 multiple choice questions, 15 statements that used a Likert scale and 11 open questions. Every question was mandatory to answer. Some of the questions were mutually exclusive and would only show to answerer depending on the answer of the previous question and of the attendance to courses. Most of the students answered 37 questions because of path-dependency.

The survey was done as a part of a program to assess the blended teaching of the EIT Digital. The survey had an objective to answer the following questions: To understand how students perceived the effectiveness of blended teaching model (Independent Leveling-up). How was the link between the classroom and online modules perceived in the studied courses and modules? To get knowledge if students felt that utilizing blended teaching, they could get more personal attention. Did students get the value that was expected with blended teaching? How the content of the online modules affected students studying/learning?

EIT Digital program to increase the quality of blended teaching had four quality components. These quality components were efficiency, effectiveness, impact, and scalability. With the staff of the EIT Digital program, we chose to focus on the effectiveness and impact components. The chosen components and indicators of if blended teaching would be effective in the students' point of view. As the goals of the survey coincided with the research question of this study, we decided to complete the survey in cooperation.

In addition to the survey, we interviewed two EIT Digital students. They were first-year students in the master program. Interviews were semi-structured. Interview structure that we used is in Appendix A: Student Interview Structure. Interview lengths were 84 minutes and 120 minutes. Interviews were a continuation of the survey. In these interviews, the goal was

to get information about how the students perceived the effectiveness of blended teaching and how they behaved during the courses. Also, there was a goal to get a deeper understanding of the reasons why students behaved as they did during the course.

### **3.6 Data analysis**

Data analysis for the thesis was done in two parts. First the within case analysis to identify the emerging themes from each case followed by cross-case analysis for identifying similarities and differences among the case courses. Regarding the within-case analysis, we identified themes in the interview transcripts and transcribed group design meetings, and we wrote detailed narratives for each case. Data gathered via participation-observation from course design meetings, informal discussions, and observation was recorded to notes and then written to detailed narratives about cases. We recorded the context of each case, what teaching methods were utilized in the case course, digital elements of the course, number of students, assessment methods, overall course structures, observations, and emerging themes from the interviews and group discussions. We analyzed then each of these detailed narratives to identify themes from each case. After within-case analysis, we did a cross-case analysis to find similarities and differences from the cases. We compared the case contexts with each other and inspected why the certain themes emerged from each case if there were similarities and differences in other of the cases.

To analyze interviews and course design meetings that were transcribed, we followed the inductive coding approach (Gioia et al., 2013). First, we read the transcribed interviews and course design meetings and we performed preliminary coding by identifying thematic quotes from the text relating to the use of digital teaching materials. We used simple codes to convey the message that was said in the quote. The second read of the transcribed interviews focused on the preliminary codes and unified the preliminary codes of a similar message to new codes. These codes formed the first order of the codes. Then we collected the unified codes and grouped the codes to find larger themes in cases. These themes formed the second order of codes. With the coding and grouping process, we did have a systematic process to go through the interviews and identify emerging themes from each interview which could be attached to narratives about each case.

The emerging themes and observations from the interviews and course design meetings were used as a basis for narratives in the case courses where interviews were conducted. In other

cases, we used the observations and fieldnotes we gathered to write the course narratives. In some of the courses, the observations came from the course design meetings which provided the information to the narrative. Some of the meetings had transcripts and then we used the same process as with interviews to find emerging themes. The rest of the observations from the course design meetings were done after meeting from memory or extracted from the audio recording of the meeting and then written into course narratives. These narratives were complemented with information available for each course such as student portals such as Moodle and MyCourses and the information found in those related to the courses such as lecture slides, lecture videos, and literature of the course. These would provide information about participation, instructions to students, grading principles, examples of study materials, and course curricula. These were used to complete the possible gaps in information and confirm information about how courses were organized to get a complete view about courses.

We used the case reports to cross-examine the cases with each other to identify the emerging patterns and differences between the cases where we derived the findings of the thesis. We compared the findings of each case with another case one by one to find the emerging patterns. We also compared the differences between the cases to assess and compare the context and environment of the findings in each case. We did the comparison to find which of the findings in the case courses could be generalized. In the end findings of the study emerged due to this cross-case examination process.



## 4 Findings from the course developments

Based on the cross-case analysis of the cases we found eight findings to address the question of how to use digital teaching materials effectively. We clarify our findings and summarize observations where we base our findings at the start of each of the sections. Then each finding is elaborated with selected observations from the case courses. At the end of each section, we discuss the implications of the corresponding finding.

We looked at the courses in differing rates of digital teaching material use and differing modalities. This meant that when we had our findings concerning the use of digital teaching materials, we can argue that many of our findings are connected more generally to contexts where teaching is practiced by non-digital and more traditional approaches.

### 4.1 *The production of educational videos*

In this section, we present our findings that relate to the production of educational videos. Which are the things that the teacher should take into account when producing educational videos and how videos should be presented and structured, so they support the learning of the student. The videos are usually directed to be viewed outside of the classroom or contact teaching. This means that students have even more chances to divert their attention to other tasks during studying than in the classroom where a teacher can activate students. Therefore, videos should be concise as it is easier to focus on a short video than a long one. Also, the presentation should be considered. Relatively quick speech and inspiring presentation help watcher of the video to keep their attention in the video and make less likely that watcher starts to multitask.

Making educational videos takes time, knowledge and resources. The amount of time and resources depends on the production value of the video. Using videos in the course can save time that teachers would normally to prepare for lecturing and lecturing contents (transferring information). If contents of the course do not change rapidly from year to year then the videos can be reused in another iteration of the course. Time saved on the videos can be used for other teaching methods on the course such as having discussions, doing cases, or giving feedback.

### *Empirical observations from the case courses*

We found that the style and format of the videos need to be carefully considered for them to be an effective tool to be used in teaching. Eight out of eleven case courses had information about the format and style of the videos that would be effectively used to support learning during the teaching. Table 7 contains the observations across the cases.

Table 7 Observations about effect of video's length and presentation in the case courses

Course	Observation
DIEM Adv Proj 2018	Course lectures were recorded. Videos were long chunks of lecture content. View statistics indicated low viewership and low retention among students.
DIEM Proj Bus 2019	Concise pre-material videos had high viewership rate and retention.
DIEM Proj Intro 2019	No observations about effect of video's presentation. Short videos on one topic similar to the style of the Oulu Proj Intro 2018.
Oulu Proj Intro 2018	Course content videos evolved from long lecture videos to videos that were 5-15 minutes long. New videos contained one topic to keep students interested and focused on watching video.
FITech Proj Man 2019	No observations about effect of video's presentation. Short videos on one topic similar to the style of the Oulu Proj Intro 2018.
FITech Marine Boost 2018	Teachers did not see that much additional benefit of reading the lecture slides in video format.
FITech Naval Arch 2018	
EIT Digital Bus Intro 2018	Some of the videos were felt to be slowly presented and students desired ability to speed up the videos. Some of the students would have preferred another method of content delivery such as scientific articles.
EIT Digital Bus Man 2018	
Bus Process Analysis & Man 2018	No observations about effect of video's presentation.
Elec Des in Eng 2018	Animations were kept short and containing only one design method per animation.

Oulu Proj Intro 2018 had a relatively new set of educational videos produced for them. The teachers described that the first versions of the videos were direct videos of lectures. Lecture videos were offered for students in open university because students could not always attend the lectures. Teachers found out that this was not the best format as videos were exhausting to watch through. They developed the concept of lecture videos to be shorter videos that all had singular topics per video. Videos were divided to be 5-15 minutes long as it was deemed to be the length that students focus would be highest. The videos were much better received than old lecture videos. A new point of criticism for shorter videos was poor audio and visual quality. The videos were not scripted and recorded through laptop webcam and microphone. They were also self-edited. To rectify poor technical quality, teachers produced a final series of the videos which were studio produced. Final video series used previous videos content

as a script. Although new videos had better audio and visual quality, teachers themselves felt that some of the naturalness was lost that previous videos had.

DIEM Adv Proj Man 2018 recorded the lectures for FITech students in Turku. Videos were unedited segments from four-hour lectures that were divided into a few parts per lecture. The videos of the lecture could be as long as 90 minutes. Overall the videos had relatively low viewership, and retention of the students was overall low. This meant that students started to watch the videos but did not finish the long video. DIEM Proj Bus 2019 had more concise videos and videos were made in a different style than videos in the DIEM Adv Proj Man 2018. There were two styles of videos. Short educational videos about singular topic and Neste Interview videos. DIEM Proj Bus 2019 used some of the same short topical videos as in FITech Proj Man 2019 and DIEM Proj Intro 2019. Videos were used in DIEM Proj Bus 2019 as pre-material as opposed to delivering lecture content as DIEM Adv Proj Man 2018 did. DIEM Adv Proj Man 2018 also had contents of the lecture available in lecture slide form. Short pre-material videos had much better viewership and retention than the lecture videos in the DIEM Adv Proj Man 2018.

The perception of benefit from the videos was not universal among the informants and the additional benefit of the videos offered was questioned. FITech Marine Boost 2018 teacher was skeptical if the videos would offer any additional value over the lecture slides. Teacher's view was, that teacher reading of the lecture slides to video and students watching that videos, would not have an additional benefit over the students reading slides. The teacher also indicated that students who wished videos could not also articulate why videos would be beneficial for learning.

EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 questionnaire indicated an overall slight positive perception about online content of the course. More students felt that videos had a positive impact on learning than a negative impact. Students felt that videos were inspiring and successful to gain attention. A minority of students disliked the presentation and would have preferred something else like reading material. Even though there was a positive perception about the online content, the survey indicated that there was room for improvements that should be done in the integration of the contact teaching into online content. They also desired more feedback online and in other parts of the course. Students wished to clarify the role of online modules and more resourcing to personal attention.

The main improvement suggestion in videos for students in EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 courses was that some of the videos were perceived to be too slow. It was the most cited presentation issue among the surveyed students. There was no possibility to change the speed of the videos. The students wanted to speed up videos because of the slow presentation in the videos. Teacher of the courses had recognized that one of the video series produced had differing format than others as it was fire-side chat format – a discussion with three participants. The pace of the discussion could have been perceived slow. One of the interviewed students said that the slowness was not a problem for them, but it might be for other students because their attention span might not be as long as theirs. Another interviewed student also cited slowness of the video series. They said that while the fire-side chat series was interesting the series was also slow and repetitive. On the other hand, they felt slowness was a good way to drive in the concepts but being long and slow it did not combine well with the multiple-choice quiz that concerned the video series.

DIEM Proj Bus 2019 had Neste interview series produced for the course. As part of the production video series, the Aalto program Aalto Online Learning (A!OLE) supported the production by offering production capability and training to video production. The author participated in the video training where was training about video presentation and production.

As a material for A!OLE course, we had a paper by Guseva & Kauppinen (2018) where they discuss that the teaching videos offer possibilities to effectively bring out specific learning content. However, videos demand a different approach than lectures or other presentations to realize the full potential. This concerns presentation, content, and visuals. Presentation in the videos should be clear and natural. If the presentation is not trained, the presentation can be stiff and too fast. Even though the presentation can be too fast but at the same time, videos are less forgiving for pausing for thinking. Pauses can be natural in lectures but in video format pausing is less forgiving as it can distract the viewer. Content needs to be straight to the point and not too long, so the attention of the viewers is kept. Visuals should also be clear and not text-heavy. There also needs to be close attention to possible copyright issues. Most common problems A!OLE found for video production were presentation skills, content, visuals, video or audio quality, and no knowledge of the production process. (Guseva & Kauppinen, 2018) A!OLE video track aimed to give knowledge and train teachers so they could make better quality teaching videos than without training.

Guseva & Kauppinen (2018) also discuss the differing production values and costs for the videos. For low production value, there are resources to do self-produced videos in Aalto. Low production value videos can be sufficient to cover topics by themselves and with reasonable quality. Better quality demands more people involved in filming and producing which takes more time and resources. Better quality should be considered if the target audience is larger than a single course and the presentation skills of the teacher is up to better quality production. Pre-production of the video and post-production should be given at least the same or even more important than actual filming. The following guidelines are for the educational videos where teacher delivering the content in front of the camera. The script sets the basis for the video. By focusing on the script can the maker of the video sets the pace for the video and have it focus on a certain topic. The script should also include possible visuals in the form of a storyboard. A storyboard is a rough idea of what are the visuals that are wanted to be in the video, order of the visuals and the text in the visuals. The script should also have pauses marked, emphasizes, and gestures scripted where appropriate. Practice before the filming helps to deliver the content clearly and it helps to shape the script that it is natural to speak through. By doing the pre-production correctly the time is saved during the later stages. Also, the quality of video increases and it is more effective when viewed by students. Post-production includes doing visuals and editing which also takes time.

### *Implications for teaching concerning the production of educational videos, and developing Proposition 1*

We discuss the implications of the production of digital teaching materials for teaching in this section. Based on the findings and implications we make our first proposition. Teachers need to recognize that the video is a different format than the lectures so teachers can produce more effective digital teaching materials. Even though videos and lecturing have similar elements as for example presenting there are crucial differences that should be taken into account. For example, the consumption of lectures and videos is different as videos are often watched independently. This means that videos should be concise as concise videos keep students' attention focused better than long videos. The presentation should also be taken into account as video can be unforgiving for the presence of distractions in the video.

Educational videos have different levels for sophistication. For example, videos and can range from self-shot via web camera to professional shot material. The first iterations of the

digital teaching material can be quickly and cheaply produced prototypes that are used to test how students receive them. These cheap productions can also be used to familiarize teachers for video production. If videos are well received and fundamental, as not likely to be changed in the near future, production value can be increased as more students would be watching them.

Because of the long production times of the educational videos, the priority should be put to materials, that can be used in teaching for a long time. The fundamentals of the course are good topics to be covered with videos because those are the least likely to change. This makes the time and resource cost of producing them more manageable as videos can be used multiple times and having videos to transfer information saves contact teaching time that can be used to interact with students.

Teachers can cover rotating material with lower production value educational videos if need be or with traditional lecturing, if that is a possibility due course targeted for normal university students. The higher quality material production is time-consuming. Offering material in person might allow more time to interaction than focusing to produce new digital teaching material if it is not certain that topic will continue to be part of the course or there will be changes in content.

Having concise videos that are presented inspiringly support learning by having students be more engaged with the videos. The long videos hinder the limited focus when students absorb new information. The inspiring presentation also helps to keep student's attention on the video. Because students can rewind the video the presentation can be relatively quick so slowness of video does not tempt to multitask and be less engaged with video. The quick speaking presentation also contributes to the conciseness of the video.

Based on the above, we propose:

*Proposition 1 (P1): The increase of conciseness and inspiring content in educational videos increases the students' active use of videos for self-study.*

## 4.2 Drivers for digitalization and organizational support of the production of digital materials

In this section, we present our findings of what drove the digitalization in case courses and how support from universities and other actors helped and supported the use of digital teaching materials in the case courses. The support in the production of the digital teaching materials helps adoption of the materials to the teaching. Most of the cases had support from their organizations to produce the materials while at the same time a reason driving them to produce digital teaching materials. The support manifested in the form of money to produce the materials. They also offered technical competence for example in cases of videos camera crews, sound personnel, other studio personnel, editors, and producers. In some of the cases, teachers were also offered a network of peers that were interested in the development of digital materials and teaching methods.

Courses had also different reasons and drivers for the production of digital teaching materials which ultimately affected how digital teaching materials were used in the courses and overall curriculum of the course. We argue that it is important to recognize the reason for digitalization so the course can be organized correctly to support the learning of the students.

### *Empirical observations from the case courses*

All of the case courses had support from a background organization or teachers had such support. The observations of support and reasons for courses to be digitalized from the case courses are in Table 8.

Table 8 Observations of support and drivers of digitalization in the case courses

Course	Support	Reasons for using digital teaching materials	Form of the course
DIEM Adv Proj 2018	A!OLE connecting teachers to a cameraman. Resources from FITech to fund the recording of the lectures.	Because of the FITech the course was offered as distance course and courses were videoed.	Contact teaching course and FITech as a distance teaching course
DIEM Proj Bus 2019	Benefitted from the A!OLE pilot to get materials to the course.	To offer students view on a empirical project and to test newly produced materials.	Contact teaching
DIEM Proj Intro 2019	Benefitted from FITech to get course contents in the video format.	There were digital teaching materials that the teacher had participated in making.	Blended teaching
Oulu Proj Intro 2018	Oulu University supported the production of digital teaching materials.	Oulu University pushed for adopting distance learning materials so open university students could be better served.	Distance teaching

FITech Proj Man 2019	Benefitted from FITech to get course contents in the video form.	Student pool from all over Finland.	Distance teaching
FITech Marine Boost 2018	Resources from FITech to provide distance teaching.	Part of FITech teaching and need to organize distance teaching in FITech.	Distance teaching
FITech Naval Arch 2018	Resources from FITech to provide distance teaching.	Part of FITech teaching and need to organize distance teaching in FITech.	Distance teaching
EIT Digital Bus Intro 2018	A!OLE pilots on developing certain modules that could also be used in courses that are shared with Aalto University students. Use of modules that other universities made.	Push from EIT to develop shared digital materials to be used across the program.	Blended teaching
EIT Digital Bus Man 2018	A!OLE pilots on developing certain modules that could also be used in courses that are shared with Aalto University students. Use of modules that other universities made.	Push from EIT to develop shared digital materials to be used across the program.	Blended teaching
Bus Process Analysis & Man 2018	Teacher received no special support apart budget for organizing the teaching.	Previous experience in utilizing digital teaching materials gave teacher confidence to use simulations during the lecture.	Contact teaching
Elec Des in Eng 2018	A!OLE pilot supporting the production of video series.	To ease the workload of the teacher.	Contact teaching

DIEM Adv Proj Man 2018, DIEM Proj Bus 2019, Des in Eng 2018 benefitted from Aalto Online Learning (A!OLE) pilot programs. A!OLE is a program at Aalto University to fund course development programs to utilize digitalized teaching. It is a network to bring together teaching staff that is interested to digitalize teaching and share the practices to the community.

A!OLE has six different themes for pilots for different aspects of the digitalization of teaching. First of the categories is Blended learning which supports the development of materials for blended learning. The second category is Languages and ARIS for pilots about language studies and augmented reality use. The third is Online social interaction to develop further possible online interactions for students. The fourth category is Online textbooks and automatic assessment to develop online materials and different evaluation tools. The fifth category is Video production and gamification to support and guide video productions for courses and different games and gamification possibilities for courses. The final category is a virtual reality to support pilots that would use virtual reality in teaching.

A!OLE offered money and support for teachers to tests different solutions of digitalized teaching and share the best practices for the community. The aim was to develop solutions that support learning. Digitalization was not seen as a time or cost saving project but as an improvement project. The program emphasized that digitalization has often high initial time and resource investment but there are benefits later in the form of improved teaching and learning. Philosophy of A!OLE was that even if the pilot project aims to replace the lectures



with educational videos the time saved from lecturing should be used back to teaching, for example in form of more interaction with students or giving feedback to students.

An example of the A!OLE support programs was A!OLE Video Track. In Video Track A!OLE offered support to teachers on how to script, produce and shoot educational videos. There was information what are the types of learning video productions, what phases learning video production contains, and what are the challenges of producing good quality learning videos. In addition to the information, the Video Track offered practical lessons in the performance in learning videos, help to script the videos, and possibility to shoot prototype videos to help perform in front of the camera.

Another organization supporting digital teaching materials was Finnish Institute of Technology (FITech). FITech as project organization was relatively small by having only 5 people working in FITech Turku project. The support that FITech offered was resources to develop distance teaching that students in whole Finland can benefit. That contributed to the development of digital teaching materials. Another supportive element in the FITech was the ability to contact a vast number of the teachers and staffs in participating universities and gather best practices in the teaching from teachers and by getting feedback from participating students.

Overall in FITech, there was variance between the preparedness of the teachers to offer distance learning courses in the technical universities of Finland. Teachers were given great flexibility to organize their courses as they saw the best. Some teachers wished more support and examples of how to organize courses which the FITech organization prepared to offer to teachers.

Oulu Proj Intro 2018 had support from the Oulu University and the local department to start to develop the digital teaching materials. Both university and case course teachers had identified that there was a demand for more accessibility for courses. The number of open university students was increasing, and Oulu intended to answer demand by offering more distance teaching courses. Educational videos and course structures were seen as a possibility to answer the demand. Oulu University offered to fund and provided technical capabilities to produce videos.

EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 both had support from EIT Digital. Because of being a pan-European organization focused on digital transformation

teaching the EIT Digital offered resources and support for digitalization. There was a need for digital teaching to harmonize the teaching. Similarly, as the FITech, EIT Digital is a parent organization and uses teaching resources of partner universities. Digital modules were seen as necessary to have common material for the teaching as otherwise the topics taught could vary too much in participating universities. Because of the cooperation, the EIT Digital can divide the workload and have some university to focus one module and another to produce different one or quizzes to some other module.

Bus Process Analysis Man 2018 did not have direct support from any organization. The teacher of the course though had worked previously in university that focused on delivering world-class distance teaching. The teacher had participated in the production of digital teaching materials and had used them in the teaching. By having previous good experiences in using digital teaching materials in teaching helped to include digital cases produced by Harvard to be part of the case course.

### *Implications for teaching concerning the support of the production of digital materials, and developing Proposition 2*

The production of quality digital teaching materials demands time, effort, knowledge and resources. The supportive structures help teachers in the production of digital teaching materials. By providing knowledge on production the materials can be improved compared to no support situation. Another is access to peer-networks that can share experiences between each other about the experiences and integration to teaching.

We regard that the support in the production of the digital teaching materials supports the use of the materials in the course. Also support in production helps to produce better digital learning materials quicker than having teachers to iterate the right formula for digital teaching materials. Having good pedagogical quality digital teaching materials support students learning.

Support of digital teaching materials also has reason to produce the materials. In the case courses, it was to accommodate distance learners, harmonize teaching and to help the teachers time management during the course.

Based on the above, we propose:

Proposition 2 (P2): *Specialized digital material development function external to course organization facilitates cross-course fertilization and learning at the school level and thereby advances the overall culture of use of digital teaching materials.*

### 4.3 Benefits and challenges of digital teaching materials

In this section, we present the benefits and challenges that were recognized in the study about the use of digital teaching materials. Benefits that were most cited by doing digital teaching materials were accessibility that students can access the material regardless of the time or location. Another widely recognized benefit that was identified was scalability. The same materials could be offered to another course or a larger audience with little extra effort for the teachers.

Table 10 provides a summary of the challenges and the benefits identified by each background organization. We found that the drivers and reasons of the digitalization also affected the perceived benefits of the use of digital teaching materials in teaching.

#### *Empirical observations from the case courses*

Teachers in the courses saw various benefits from the production and use of digital teaching materials. Collection of benefits that different teachers saw in the case courses are in Table 9.

Table 9 Observations about benefits of digital teaching materials in the case courses

Course	Observation
DIEM Adv Proj 2018	No observations about perceived benefits.
DIEM Proj Bus 2019	In addition to scalability and reachability the possibility to share practical examples from real life companies and deliver those experiences to students via videos.
DIEM Proj Intro 2019	Possibility to free up the classroom time to discussions and not be shackled to teaching materials that are asked in the exam.
Oulu Proj Intro 2018	Scalability and reachability main benefits.
FITech Proj Man 2019	Scalability and reachability main benefits. Target audience students in Finland for FITech Turku.
FITech Marine Boost 2018	No observations about perceived benefits.

FITech Naval Arch 2018	No observations about perceived benefits.
EIT Digital Bus Intro 2018	Benefits were scalability and harmonization of the teaching. Same materials can be shared in different universities in Europe. Teaching was seen more accessible for students. Students could work together across the universities.
EIT Digital Bus Man 2018	Benefits were scalability and harmonization of the teaching. Same materials can be shared in different universities in Europe. Teaching was seen more accessible for students. Students could work together across the universities.
Bus Process Analysis & Man 2018	No observations about perceived benefits.
Elec Des in Eng 2018	Main benefits were scalability and reachability that helped teacher's workload.

Oulu Proj Intro 2018 saw that the benefits of digital teaching materials were scalability and reachability for students. Driver for Oulu Proj Intro 2018 was an increased number of life-long learners from the open university. They might live further away from the campus and have limited time to participate in the teaching sessions that happen during the workday due their day to day jobs. The digital teaching materials offered better accessibility for those students. When there were positive experiences from open university distance courses and video implementation of the basic course, a similar change was implemented to bachelor's level basic course. The reasoning was the timing of the lectures was not engaging for students and students seemed to prefer change to an online learning model.

FITech Proj Man 2019 had similar ideas about scalability and accessibility as Oulu Proj Intro 2018. For FITech the target audience for courses are all the students in Finland and especially students in Turku but teachers of the courses can be in other universities. Rather than to have everyone to always travel to Turku the rationale was to start to digitalize the courses so teaching can be offered without strict location and time requirements.

Table 10 Background organizations, drivers for digitalization, benefits, and challenges

Background organization	Main drivers for digitalization	Benefits Identified	Challenges Identified
Oulu University	Accessibility for students	Scalability, students can study when they are most receptive to studying	Resources to videoing, lack of social aspect of studying
FITech Turku	Freedom of a specific location for teachers and students.	Accessibility, freedom of place, network university faster to establish than a regular one, flexibility	Different preparedness of the teachers to implement online teaching
EIT Digital	To ensure that every student gets the necessary knowledge base in each of EIT university	Teachers and faculty: Scalability and economic efficiency, Harmonization. Students: material availability, platform offers the possibility to collaborate with distant peers	Distinction between online material and classroom material
Aalto Online Learning	To use technology to improve learning experience	Material availability, more time with students when lecturing digitalized, the possibility to simulate otherwise difficult situations	Resources to develop, initial time costs

EIT Digital shared the views on accessibility and scalability as previously introduced case courses. Though two extra benefits that were recognized was the harmonization of the material that could be achieved with the digital teaching materials. This was needed as the students change the university during the program and teachers need to guarantee that students have studied the material for the advanced courses. EIT Digital saw that they could benefit from the network as they could share the materials and achieve cost reductions in the form of cheaper materials than individually produced. Also, they saw that using blended teaching there would be less need for contact teaching.

EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 utilized that there were online modules that allowed independent studying on certain topics to go through a different emphasis on the lectures. The mandated topics that were in the EIT Digital program were covered by the digital teaching material. Contact teaching could then focus more on the topics that teachers of Helsinki node deemed the most important and utilize the business connections to offer teaching that could not be replicated in other universities.

DIEM Proj Bus 2019, DIEM Proj Intro 2019 and Des in Eng 2018 also identified the scalability and additional accessibility. In addition to those, the teachers identified additional benefits related to teaching and learning. DIEM Proj Intro 2019 used the same educational

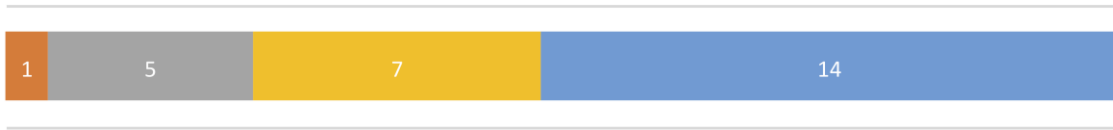
videos as FITech Proj Man 2019, but the course was structured in blended teaching model rather than being distance teaching course. The lectures were introductions to topics, about the assignments and questions. The teacher described that it was freeing that they did not have to focus on to go through topics for the exam in detail. The material was available in video form and in the book and there was a supportive structure in the form of multiple-choice quizzes. This allowed the teacher to introduce and discuss examples and challenges of project management rather than have been shackled to materials that the teacher had to go through.

Des in Eng 2018 and DIEM Proj Bus 2019 utilized the educational videos to get experiences from the practitioners to the students. Des in Eng 2018 had videos series from the designers that described their own experiences in the design process. Students could learn from experienced designers. Similarly, DIEM Proj Bus 2019 offered two video series about projects and the experiences of project personnel that could be analyzed and learned from. Similar experience sharing could have been achieved with quest lecturer. However, the videos allowed a more diverse discussion of viewpoints than singular quest lecturer could offer. It also removes scheduling problems that might arise if quest lecturer is invited. As teacher and practitioners made video series together that allowed constructing pedagogical frameworks around the videos that teachers perceived to be helpful in learning. However negative of the videos compared to quest lecturer was that students could not ask questions.

### *Student perception of the benefits of digital teaching materials*

The students in EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 agreed the most with the statement that online modules allowed them to study when they wanted. Distribution of answers is in Figure 1. Students felt that there was flexibility with the implementation of the online modules. Most of the students decided to use this flexibility to study the material after the lectures at their own pace.

## EIT DIGITAL: ONLINE MODULES ALLOWED ME TO STUDY WHEN I WANTED



	1	2	3	4	5		Total	Average	Median
Online modules did not allow me to study when I wanted	0	1	5	7	14	Online modules allowed me to study when I wanted	27	4,26	5
	0%	4%	18%	26%	52%				
Total	0	1	5	7	14		27	4,26	5

Figure 1 distribution of EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 students answers to claim “Online modules allowed me to study when I wanted”

The student in EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 felt that the digital teaching materials delivered on the promises of easily accessible materials and that the digital teaching materials allowed them to choose the timing of studying.

### *Implications for teaching concerning the benefits and challenges of digital materials, and developing Proposition 3*

Even though most teachers identified the benefit of digital teaching to be the accessibility and scalability there were examples that digital materials could improve the contact teaching. The material that is available in online offers the contact teaching freedom to focus on topics that were previously disregarded to accommodate the topics that would be in exams. We regard that the main benefits that the teachers saw had roots on the reasons that got the teachers to make the videos. For example, the accessibility for distance learners if there were a lot of distance learners in the course.

Teachers perceived that videos would be scalable. They had an idea that the videos could be shown to a larger group of people with little extra effort on the teachers’ part. However, teachers did not seem to want to use that much videos that they were not participated in making. Videos were scalable in a teacher’s own teaching. They could show the video over and over again when applicable in their courses, but videos were not scalable in the sense that they would be applied in other universities. EIT Digital did offer an exception to this as

their teachers would use videos that were not produced by themselves. However, that is due to participation in a common program which demands common materials. Though even then the emphasis on different modules was differing and be based on themes that teachers thought that were the most important. This may be an indication that teachers given freedom would like to use other materials.

We regard that teachers recognizing the strengths of digital teaching materials and the right use of digital teaching materials supports learning as digital teaching materials are then used in right contexts and situations. Teachers can apply digital teaching materials if they feel that digital teaching materials are an applicable tool to use in a situation.

Digital teaching materials are accessible so they support learning for students that cannot make to lecture. They are scalable in a way that digital teaching materials can be used in different implementations of the same course and then save time during the course implementation. Then the digital teaching materials support learning if the teachers use the additional time to focus on the activities that support learning such as giving feedback and employing active learning during the contact teaching. Digital components can be introduced to teaching and improve teaching. Digital teaching material improves flexibility when students can access teaching material. Producing digital material leaves more time to be used during the courses to do other things than preparing and lecturing. These can be designing new assignments done in lectures or out of the classroom. This gives teachers more time to give individual feedback or otherwise engaging with students.

Digitalization of teaching has costs associated to in by taking time and money to produce digital teaching materials. The consideration should be what are the materials that could benefit from transferring to digital form, so they save time in the long run. Time saved can be transferred to engage more with students.

Based on the above, we propose:

*Proposition 3 (P3): Increasing the accessibility of the teaching materials by transferring them into digital format enables teachers to increasingly require that students are acquainted with the materials in their self-study time. This increases further preparedness of students coming to contact teaching events.*



#### *4.4 Use of grading to motivate the students to study digital teaching materials*

This section presents our findings on how to use grading to motivate students to use digital teaching materials. Our observations point to the direction that students are heavily motivated by getting a good grade and passing a course. Teachers can use this to steer students' attention during the courses. We argue that teachers using grading to motivate student complete learning events applies to all learning events. Learning event can be the use of digital teaching materials in studying or more traditional ones such as attending to lecture. In the context of the thesis, a learning event is a learning activity where a student uses their time to study and learn. It can be anything from attending to lecture, watching a video, writing a learning diary or solving case assignment in a group. Students showing value to an event is in this context the attendance, completion, and time-contribution to the learning events.

We observed that attaching grading to a learning event increases the valuation of the event. Students seem to complete the learning events that award points towards the grade more than optional learning events. The students steer their effort to learning events that are required to pass the course or award the points to increase the grade. The graded learning events had, depending on the type of the learning event, more attendance, more attention and more effort put to them compared to similar learning events that did not have grading attached to them.

We observed that the grading had a motivating effect on some of the students. Students seemed to put more effort and be more motivated due to the task and grading. For some students graded learning events seemed to be forcing them to do the task. However, regardless of the student perception, the completion of the graded learning event was better than the learning events that did not have grading.

##### *Empirical observations from the case courses*

In the empirical study, we found that each case course had learning events that were graded during the course. We observed in seven out of eleven case courses that students valued learning events that had an effect on the grade more than learning events that did not contribute towards assessment. Table 11 contains the descriptions of graded learning events and examples of differing valuation in the case courses.

Table 11 Observations about graded and non-graded learning events and different valuation between those in the case courses

Course	Examples of learning events that included grading	Examples of differing value between graded and non-graded events
DIEM Adv Proj 2018	Group cases. Teachers intended that group cases would prepare students for the lectures. Exam.	Group cases were completed in time. Low lecture participation throughout the course.
DIEM Proj Bus 2019	Learning diaries that should analyze the pre-materials and the lecture. Reflection Essay.	Students would complete all the learning diaries with few delays. High participation in the first lecture. Lowering participation in lectures throughout the course.
DIEM Proj Intro 2019	For each week multiple-choice quiz. Questions were about the topic of the week that could be studied from videos or course book.	The high response rate to quizzes as they affected to grading. Students therefore are looking the videos or reading the materials in a weekly rhythm affected by the weekly quiz deadlines.
Oulu Proj Intro 2018	For each week multiple-choice quiz. Questions were about the topic of the week that could be studied from videos or course book.	No observations about differing valuation.
FITech Proj Man 2019	For each week multiple-choice quiz. Questions were about the topic of the week that could be studied from videos or course book.	No observations about differing valuation.
FITech Marine Boost 2018	Learning diaries about course topics that were covered over the summer.	Penalizing missing deadline in grading. According to teacher, the students were well motivated and returned the assignments as agreed.
FITech Naval Arch 2018	Ten weekly assignments that corresponded with the topic of the week.	No observations about differing valuation.
EIT Digital Bus Intro 2018	Mandatory online module that included a series of videos and a multiple-choice quiz.	Voluntary video modules were less watched than mandatory video modules.
EIT Digital Bus Man 2018	Multiple mandatory online modules that included a series of videos and a multiple-choice quiz.	Majority of students thought that overall multiple-choice quizzes helped the learning. Helping effects were more motivation to study and pay more attention. Contrasting accounts described that tests were distracting from learning.
Bus Process Analysis & Man 2018	Graded assignments that were done during some of the lectures. Case presentations, case feedback, simulation exercises.	Course had mandatory assignments during some of the lectures. Lectures that did not have mandatory parts had considerably lower participation.
Elec Des in Eng 2018	Lectures had impact on grading. Learning diaries that should include reflection of project and videos that were part of the course.	No observations about differing valuation.

DIEM Adv Proj 2018 had graded learning events and not graded learning events during the course. Cases and the exam were the graded learning events and lectures were not graded or awarding points towards the grade. During the course, the cases that were done before each lecture had a high completion rate. The lectures that did not contribute to grade directly had a low participation rate. Students did not either watch lecture videos that much as a substitute for participating in the lecture.

DIEM Proj Bus 2019 had a similar situation as the DIEM Adv Proj 2018. DIEM Proj Bus 2019 had graded learning events during the course in the form of the peer-reviewed learning

diaries. Students focused their efforts on the learning diaries first and foremost in the course. Participating students provided the learning diaries each week and review process with only minimal delays. Comparing this to lectures that did not award points such as the lectures the participation was much lower. DIEM Proj Bus 2019 had also a really small number of late submissions during the learning diary track. The course, in addition to attaching grading to the learning diaries, imposed penalties to the grading of learning diary if the students would return the submissions late. Only ten out of a total of 233 learning diary submissions during the course were submitted late.

FITech Marine Boost 2018 had similarly imposed harsh penalties if the deadlines were missed but offered negotiation room to agree on a new deadline if the students would ask the new deadline in advance. The new deadline would then be final and non-negotiable. The system was felt that it reflected the marine industry. If the deadline is set, then it should be honored as in shipbuilding there can be enormous costs associated on being late. Cruises being booked that need to be canceled and that would reflect poorly on the industry and companies but if something is agreed sufficiently in advance then there can be flexibility. Teachers wanted to instill this type of mindset to the students in the program. During the FITech Marine Boost 2018, tight schedule and method of working was successful and students were motivated throughout the course. However, during the FITech Naval Arch 2018, there were problems with students that were not accustomed to this system and wanted to negotiate new deadlines if the original was missed.

Bus Process Analysis Man 2018 course shared students valuing graded learning events phenomenon. Most of the lectures had case presentations or simulations that were graded attached to them. Groups that had solved cases had to present them and presentation affected to the grading. Similarly, the other groups had a responsibility to give feedback about the case and the presentation. The feedback had also a small effect on the grade. Some of the lectures also contained simulation cases that were also part of the grade. Overall the attendance number to the lectures where was learning events that were graded was really good with almost all the students participating.

Even though most of the lectures had the grading attached to them in Bus Process Analysis Man 2018 there were couple lectures that did not contain any parts that affected the grade. Excluding the starting lecture which typically has a lot of participation, there were lectures where was no graded learning events. One of the lectures where was no graded events had

only eight out of forty students present at the start of the lecture. Ten students arrived late to the lecture and in the end, it had approximately half of the normal amount present. Another instance described had only eight students present at the start of the lecture and after the break mid-lecture, only two students were remaining. The reason offered by students for low participation was student association organized ski-trip to Lapland and most of the students participated in that.

EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 courses utilized the graded multiple-choice quizzes to ensure that the students would watch the videos in the modules that were common to all of the EIT Digital students all across Europe. The contents were seen as vital for every student in the program to learn so when a student would transfer to another university to complete the second year of master studies the teachers in the second university could expect that certain topics were taught in entry year of the program. Students needed to complete each multiple-choice quiz with points six out of ten to meet the minimum requirements that EIT Digital required.

All case courses utilized some sort of graded learning event during the course. Elec Des in Eng 2018 had learning diaries which required analysis of educational videos, FITech Proj Man 2019, Oulu Proj Intro 2018 and DIEM Proj Intro 2019 had multiple-choice questions relating to the weekly video sets. FITech Marine Boost 2018 had a learning diary that required reading articles during the course. FITech Naval Arch 2018 had assignments relating each week's lecture theme. These courses all have assignment learning events and linked some other material to the assignment continuing throughout the course.

Observations in the lectures in DIEM. If the lecture attendance was voluntary in the course, the participation in the lecture was about half of the enrolled students. At the first lectures of the course, participation was higher than in the later lectures. Mandatory participation seems to increase participation in lectures. However mandatory participation in lectures does not guarantee in any way that students present in the lecture actually use their time to the pay attention to teaching. Students have laptops and mobile phones and can easily divert their attention to those if the lecture does not seem to provide them value.

### *Evidence from EIT Digital students*

Students opinions about quizzes in a form that EIT Digital used were split as seen in Figure 2. Overall there was a positive inclination that tests and quizzes supported the learning. The

largest group of students felt that the tests and quizzes slightly helped to learn. However, 22 % of the students that felt that tests and quizzes hindered their learning.

### EIT DIGITAL: TEST AND QUIZZES HELPED MY LEARNING



	1	2	3	4	5		Total	Average	Median
Tests and quizzes hindered my learning	3	3	7	12	2	Tests and quizzes helped my learning	27	3,26	4
	11%	11%	26%	44%	7%				
Total	3	3	7	12	2		27	3,26	4

Figure 2 distribution of students in courses EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 answers to claim "Tests and quizzes helped my learning"

Overall opinions were divided on multiple-choice tests and quizzes as implemented in the EIT Digital Helsinki. About half of the students felt that they had a positive impact on learning. Rest felt that it had little effect or even hindered the learning. For 49 %, the tests motivated to study more and pay more attention. For 22 %, the effect was completely opposite, and they felt that tests hindered their learning process as the focus went to pass the tests rather than to understanding the topic.

Following open question "How did the tests and quizzes affect your learning?" had 6 responses we classified as negative, 7 neutral and 14 positive responses. Even though the distribution was the same as Likert scale question in Figure 1 that does not mean that we classified them necessarily similarly as students did in their assessment of learning. Positive impact responses were that tests made them pay more attention to the videos and make notes and revise videos if there were gaps in their knowledge. Also, in positive responses students felt that tests helped to identify the main points of the videos and to summarize them. Neutral responses were that tests had little effect on the learning and served more or less only as an assessment method. One neutral response considered that tests helped to confirm that students had learned topic when test went well, and tests were useless when students answered wrong and had no feedback to correct gaps in learning. Negative responses were

that tests shifted students focus to pass the tests rather than learn the content in the modules. Some negative responses were that tests were a laborious task of looking at details in the videos and test were a work that had to be completed but did not help the learning. Negative responses had a similar view as neutral responses that the tests were seen as an additional task that had little effect on learning. The overall tone in negative responses was more negative than in neutral responses.

Two interviewed students elaborated the reasons why some students as they did not appreciate the online tests and quizzes. They shared the feeling that tests were used only to assess the student and did not see the motivating benefits that were described by some of the survey responders. Some of the questions were felt to focus on small details and did not help students to understand the big picture. Some of the questions were also felt to be ambiguous and have no clear correct answer.

EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 both utilized mandatory video modules that had multiple-choice quizzes attached to them and optional modules that did not contribute to the grade but provided additional information and helped to understand overall learning outcomes of the course. Optional modules that did not have tests assigned had a lower rate of students that watched all of them compared to the mandatory modules. There was 8-20 percentage of students that did not watch any of the videos in different optional modules. Students that did watch all of the videos ranged from 36 % to 56 % in optional modules depending on the module and topic. This was asked on the individual module level.

However, there might have been some uncertainty among the students that which of the modules were optional and which mandatory. When students were asked if they watched optional online module videos only 12 % said that they watched all of them, 36 % said that they watched some of them and 52 % said that they did not watch any optional videos. Numbers were completely different in individual modules where only 8-20 percent of the students said that they did not watch any of the videos in these.

Students' logic for watching optional videos were to familiarize themselves with interesting topics and leaving less interesting unwatched. Their reasons for not watching optional videos were not having enough time and the workload was perceived to be high with mandatory

ones already. Some of the students responded that they would watch the rest of the optional videos during vacation time because then they would have more free time.

The first interviewed student had watched the optional modules after the courses during Christmas break. Student cited the amount of work to be the reason that they watched the videos after the course. The student said that they were interested in the topics and wanted to learn all that was available and therefore watched the optional videos. The second student said that they did not watch the optional videos due to a bad experience with mandatory videos. The second student was disappointed with the style of the questions. The student had also watched a whole module of videos on one sitting which took four hours. Afterward, they found out that multiple-choice questions required a lot of detailed information that required the student to re-watch a lot of videos. This experience made student demotivated to watch the optional content.

#### *Implications for teaching concerning the use of grading to motivate students to use digital materials, and developing Proposition 4*

Students value the learning events that award points towards grade more than other learning events. This manifests by increasing participation in events that award grade and increased completion rate compared to learning events that are not graded. We regard that teachers of the courses should use this mechanism to steer student focus to the learning contents that they deem valuable. These could be watching videos or participation in lectures by assigning a grade to participate in the learning event. Alternatively, teachers could assign graded assignment such as learning diaries or quizzes that demand to study the contents of the video, book chapter or lecture to pass the assignment.

We regard that students value the grade that they receive from the course highly in most of the case courses for example in Aalto DIEM, but at the same time optimize their time use. In the student's perspective, a singular course is only one thing to invest their time and their alternatives for investing time and attention are other courses, possible job, and a social life that also demand student's time. A student might want to direct their efforts on individual course to learning events such as assignments or exam that contribute towards the grade because of the time constraints. By offering students incentive to complete the task the incentive motivates the students to watch the videos or attend the lectures and pay more attention to them compared to other tasks that student might have.

The amount points that learning event awards do not need to be big for motivating effect to manifest as students complete smaller tasks if they contribute towards getting a higher grade. We regard that this should invite careful consideration of what are the learning events (watching an educational video or completing a report) and contents that are the most valuable for students in a course. If the students put the most effort in those learning events that award the grade, then teachers should recognize this and structure the grading so that the most important contents and learning events are reflected in the grading of the course. Motivating effects of the grade then steer the students' efforts towards the most important learning events.

If we suppose that a learning event is such that completing the learning event contributes to learning the indented learning outcomes, then having grading attached to the learning event supports learning by having students be more motivated to participate and complete the learning event. The grading can be used as an effective mechanism to guide the students' attention towards the important learning events that contribute towards learning.

Based on the above, we propose:

*Proposition 4 (P4): Students' studying efforts on digital teaching materials can be planned to affect students' effort by making particular tasks, exercises, and assignments to contribute to the overall grade.*

#### **4.5 Use of assignments to motivate students to study digital teaching materials**

This section presents findings about using assignment to motivate students to study materials that are needed to complete the assignment. Assignments that need to be done and affect to student's grade had really high completion rate in the case courses. Teachers can use this to make students to study important materials from the course.

A course comprises of multiple learning events and topics. Multiple learning events can handle the same topic in the course. An example of linked learning events could be a topic about managing risks that could have following learning events: watching pre-lecture videos and pre-readings, multiple-choice quiz on the pre-materials, lecture, learning diary or an



assignment based on the lecture, and at the end of the course exam that possibly has questions about risk management. These are learning events that are linked together by the topic of managing risks and they serve the purpose that student learns about risk management.

It is not feasible to award points for grade for any learning events. For example, points affecting the student's grade could be awarded for watching an educational video but in practice this does not guarantee that the video is watched if not done in controlled environment. Even though, awarding points might lead to increased viewership of the video in statistics, it does not guarantee that student actually watches the video, because there are no control mechanisms to monitor individual student, that they actually watch the educational video. Grading can be attached for some learning events such as lecture. In a lecture the teacher can see if the students participate in lecture or not. Assignments are another type of learning event that can be assessed as they produce an artefact (for example report or calculation) that can be graded. Teachers can link learning events where studying cannot be directly controlled such as reading article or watching a video to other more easily confirmed learning events such as writing a learning diary or multiple-choice quiz where students do a task that can be assessed.

Graded learning events increase the completion rate of the graded event as compared to other learning events in the courses that do not use the graded learning events. Courses use the increase in the completion rate by linking graded learning events such as assignments that demand to study other learning events such as lectures or video sets. It might be possible to complete the assignment without studying the other material, but it is harder without the previous knowledge gained in the earlier learning events.

We observed case courses using a graded learning event as to ensure that others not directly graded material is studied for example multiple choice quizzes to ensure that videos were watched (e.g. Oulu Proj Intro 2018). Even though, graded learning event can increase the study rate of a learning event, but it is not a guarantee that linked learning event is utilized by students fully. Attaching a graded learning to another learning event needs to be closely linked in time and in correct form. The exam that links into every previous learning event during the course does not guarantee the use of previous learning events such as attending to lectures. If students are required to analyze video with guiding questions and write a short review, the students put more emphasis on watching the videos and the aspects that are

questioned because the learning events (watching the video and writing the review) are more closely linked than lectures and exam.

### *Empirical observations from the case courses*

All of the case courses had linked learning events. For example, exam that is used to assess the whole course and, in a way, linking the contents to one learning event. Other examples were having learning event of watching a video and having contact session that handled the video linked together. Six of the eleven case courses had students that did not utilize linked learning events as teachers planned that they should be studied. Table 12 contains the examples from the case courses.

In the DIEM Proj Bus 2019, one of the graded learning events were learning diaries and peer-review process attached to it. The intention of the learning diaries was that the students would study the pre-materials, participate in the lecture, and then deepen and reflect the learned material in diary form. Then having done the whole process they would be capable to review and give feedback for other learning diaries and in the best case learn from insights that were in reviewed learning diary. The learning diary was a graded learning event that was intended to be linked with the lecture. By requiring the students to write the learning diary and giving feedback from others was thought to encourage the students to attend the lectures. This intention this not materialize fully. The first lecture had a large number of participating students, although some of the participating students were just seeing if they would be interested to take the course and used the first lecture to gauge the interest. In subsequent lectures, the participation rate dropped in each lecture and at the final lecture, there were only four students out of thirty participating.

Even though the lectures had a low participation rate the learning diaries were written and reviewed by almost all the students each week. Students were content to use the pre-materials available to them to fulfill the learning diary and skipped the lecture. There was one exception to the lowering attendance rate in the lectures. One of the lectures had a case from the marine industry and it utilized interview videos from the case company. The videos were preliminary and were not available for public distribution at the time of the lecture. Therefore, there were really limited pre-materials available for students compared to other lectures. The participation to lecture was greater than in the couple lectures before or the subsequent lectures. The learning diaries made students look through the material and the

best students supplemented learning diaries with other written material and references if they did not attend to lecture. However, learning diaries did not have the desired effect for students to come and discuss the topics during the lecture.

Table 12 Observations about linked learning events and varying completion of linked learning events in the case courses.

Course	Linked learning events	Examples of students not using linked learning events
DIEM Adv Proj 2018	Pre-materials, cases and lectures linked. Exam tying the whole course together.	Students had low participation in lectures during the course.
DIEM Proj Bus 2019	Pre-materials, lectures and learning diary. Reflection essay at the end of the course.	Students skipped the lectures and the made the learning diaries based on the pre-materials
DIEM Proj Intro 2019	Weekly Video Sets and Multiple-choice quizzes. Exam at the end of the course.	No observations about students' use of learning events.
Oulu Proj Intro 2018	Weekly Video Sets and Multiple-choice quizzes. Certificate test at the end of the course.	No observations about students' use of learning events.
FITech Proj Man 2019	Weekly Video Sets and Multiple-choice quizzes. Online take-home exam at the end of the course.	No observations about students' use of learning events.
FITech Marine Boost 2018	Research articles and learning diaries. Project work connecting the whole course topics.	No observations about students' use of learning events.
FITech Naval Arch 2018	Lectures and weekly assignments. Exam connecting the whole course.	No observations about students' use of learning events.
EIT Digital Bus Intro 2018	In online content: videos and quizzes linked together. In classroom assignments and lecture contents.	Even in mandatory modules, students did not watch all the videos. Students cited being able to deduct the right answers by recording the previous answers and trying again.
EIT Digital Bus Man 2018	In online content: videos and quizzes linked together. In classroom large group project work linked together all the learning topics of the course.	Alternative hypothesis was also offered by teaching staff that the students shared the right answers with each other.
Bus Process Analysis & Man 2018	Exam covering the whole course.	Students skipping the lectures that did not have any graded content had the teaching staff to include questions about content especially from those lectures to exam.
Elec Des in Eng 2018	Learning diaries and online videos about designer insights and methods.	Students reflected the designer videos in the learning diaries. The students did not reflect on method animations in the learning diaries. Mistakes that could have been rectified by watching the animations were present at the project work reflections.

ELEC Des in Eng 2018 had similarly learning diaries as part of the course. Learning diaries were divided into two parts. First part focused on reflections on the videos about designers

and animations about the design methods. The second part focused on the project work and had a suggestion that student should refer to meetings in the classroom and videos in this part. Students reflected the designer interviews in the learning diaries, but students had few references to method animations in the learning diaries. The teacher felt that designer interview videos were sufficiently covered with learning diaries by reflection showed in them. Lack of reflection of the method animations also showed in the project work as there were mistakes in the process of the project work. These mistakes could have been rectified easily if students would have able to transfer the contents of method animations to practice.

As previously described EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 used multiple-choice quizzes to ensure that students would watch videos within mandatory modules. However, assigning modules mandatory did not make students watch all the videos in corresponding modules. For mandatory modules had a sizeable number of students that did not watch all the videos. Students that watched all the videos in mandatory modules were 60 % at the EIT Digital Bus Intro 2018 and 62 % in the EIT Digital Bus Man 2018. Rest of the students watched some of the mandatory videos but not all. The questionnaire did not go deeper to the subject of how many of the mandatory videos the students left unwatched.

Even though linking the videos with multiple-choice quizzes and having modules mandatory increased the self-reported watch-rate compared to non-mandatory modules, the linked multiple-choice quiz did not ensure that all the videos were watched in the EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 courses.

Interviewed students of EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 courses felt that multiple choice questions were an unfair way to assess students. Students felt that in some of the tests it was hard to score satisfactory points even if they felt that they had studied material properly. They felt that at the same time student could have done random guesses and iterated correct answers based on the guesses as there were multiple tries to complete the test. Students felt disheartened and demotivated as their efforts to try and study the topic had similar results as what could have been achieved by five minutes of random clicking of options.

Online module quizzes received some critique from students. It was felt that some of the questions demanded literal answers from the videos and the type of the quiz was to ensure that the video was watched instead of the topic learned and analyzed. There was feeling that

some of the questions were open to interpretations and closed questions in multiple choices made the quiz more guessing game than the right tool to assess learning.

The overall workload of the EIT Digital program was felt by interviewed students to be heavy. EIT Digital students have limited study time as opposed to a Finnish university student who have five to seven years to complete their studies. There is no similar flexibility for EIT Digital students. As there are a lot of mandatory tasks that need to be completed it results in finding shortcuts to complete assignments. In online multiple-choice tests to try and do them without watching accompanying videos. One of the shortcuts described in the survey was to do a quiz one time and to record the answers. Because there were three chances to do the quizzes the student could use iterations to answer correctly and without watching the related material.

*Implications for teaching concerning the use of assignments to motivate students to use digital materials, and developing proposition 5*

Teachers should consider which learning events in the courses should be contributing to the grade and how the learning events are organized that they best contribute to the learning. The students seem to value and complete the tasks that award points towards the final grade. Teachers should utilize this to get students to focus on the most important learning events.

Based on the empirical material we regard that teachers should carefully think which the most important learning events for the students are learning. These learning events should then be assigned tasks for students that are assessed. If the lectures are seen as a vital learning experience for students, there should be task associated with the lecture that strongly encourages participation or even awards the point directly for participation. If teachers think that the most benefit is received by students studying the pre-materials by heart, then teachers should associate a task with the pre-materials. The benefit to attend the lecture or to do something for the task should also be clear so that students do not feel like they can skip the teaching event and still do the associated task.

The form of the graded learning event needs to be considered carefully if it is expected to link to the materials that are independently studied as is the case with the digital teaching materials. Multiple-choice quizzes can be a functional way to encourage students to go through the material in some circumstances and topics for example if the material demands only memorization. For topics that demand more deeper learning or do not have a singular

solution but context-dependent solutions with differing benefits and drawbacks, a short essay might be a better solution. If there is a large amount of material that is required to be gone through for an assignment, then there is a possibility that students focus only on certain aspects of material while disregarding others as was the case with ELEC Des in Eng 2018 method animations. Therefore, it should be recognized what are the most critical learning outcomes or topics and guide the students to focus on those with the assignments.

If we suppose that participating in learning events contribute towards the learning, then the increased participation of linking learning events is supporting learning by having students to complete learning events. As established, linking a graded learning event to another is not guaranteed way to increase participation in other non-graded learning events if students feel that they can complete the graded learning event without completing the non-graded learning events. We regard that it is best to award the points toward the grade for the most important learning events if possible and if not then link the learning events as closely as possible that completion of graded learning event demands the completion of other learning events.

Based on the above, we propose:

*Proposition 5 (P5): Studying of non-graded digital materials can be increased by connecting non-graded material to an assignment that demands the studying of the material.*

#### ***4.6 Planning of course curriculum – scheduling digital teaching materials and assignments***

In this section, we present our findings on the effect of deadlines on students' studying effort and how teachers can use this effect to structure the course to support learning. Students concentrate most of their studying effort to the time right before the graded learning event is scheduled or has a deadline. The impact that the learning event has on the grade seems to have some effect on the preparation time but not too much. For example, an exam makes student prepare for a few days while learning diary entry makes students start doing entry day or two before the deadline. However, as an exam often covers all the topics in the course preparation time of three or four days might not be enough. Therefore, teachers should consider having multiple small assignments to encourage students to rhythm their studying

more evenly. In addition to deadline-orientation, the students seem to choose rather later starting date for assignments than trying to do the tasks in advance even when possible.

### *Empirical observations from the case courses*

Five out of eleven case courses had observations of students' behavior that most of them preferred to do assignment and other learning events as late as possible. In addition, five courses had also made course schedule so that it contained smaller assignments during the course to have students to do some assignments and studying for the assignments during the course. Table 13 contains observations from the courses.

Table 13 Observations about effects of deadlines on student behavior in the case courses.

Course	Examples
DIEM Adv Proj 2018	Lecture videos watch spikes right before the exams.
DIEM Proj Bus 2019	Learning diaries were mostly returned during the due date. Of total 233 submissions, 152 were returned on the due date.
DIEM Proj Intro 2019	Multiple choice questions staged to have evenly distributed deadlines during the course.
Oulu Proj Intro 2018	Multiple choice questions staged to have evenly distributed deadlines during the course.
FITech Proj Man 2019	Rather than utilizing the tutoring sessions during the week to ask questions about the weekly assignments the students tried to ask questions on Sunday (due date).
FITech Marine Boost 2018	Learning diaries and project work meetings during the course.
FITech Naval Arch 2018	Weekly assignments during the course.
EIT Digital Bus Intro 2018	Course had set the deadline for completing mandatory modules at the end of the course. Students were able to choose when to complete the modules.
EIT Digital Bus Man 2018	When freely able to choose when to complete modules students opted to complete later than in the doing modules as they were published.
Bus Process Analysis & Man 2018	No observations about curriculum and students' studying efforts.
Elec Des in Eng 2018	Learning diaries in the course.

Some of the pre-materials in DIEM Proj Bus 2019 were videos. Videos were accompanied with tools to analyze the statistics of when the students watched the videos. Most students watched videos the same day of the lecture or day before. Additionally, there was another spike in viewings right before the deadline of the learning diaries. Even though the course staff provided materials usually a week in advance the students studied the materials the most right before the lecture and learning diary submission.

DIEM Proj Bus 2019 learning diary submission data also supports the statement that students concentrate their efforts right before deadlines. All submissions had at least half of the students returning their learning diary during the day that submission was due. This meant

that over 15 students out of the 29 submitted their learning diaries the day that had the deadline.

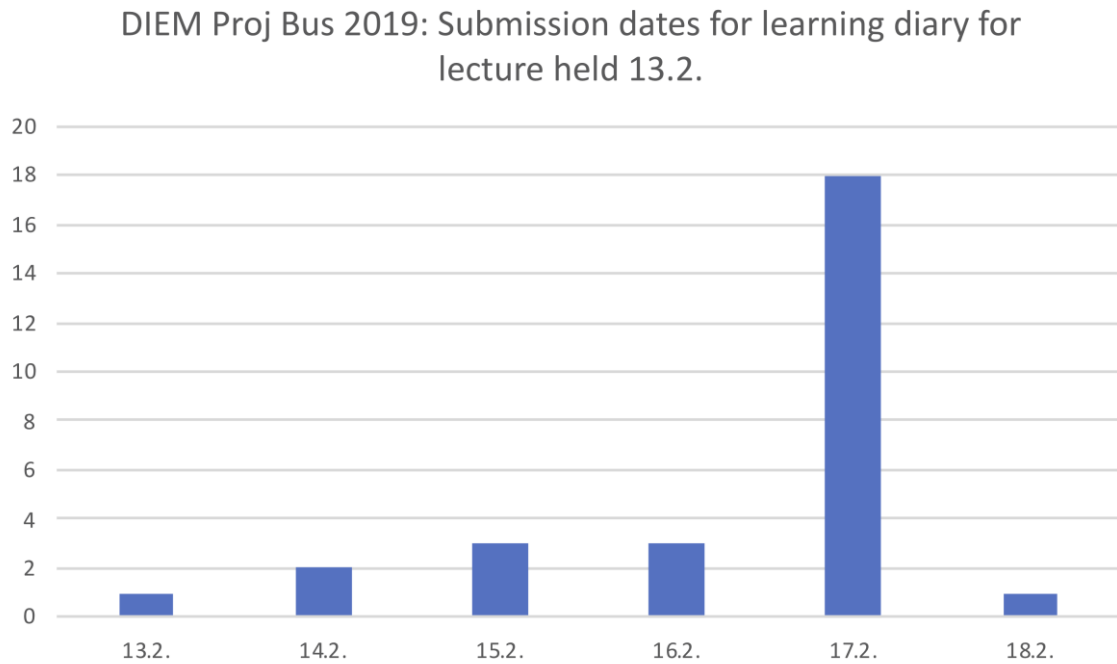


Figure 3 submission dates for learning diary due 17.2. for lecture held in 13.2. in DIEM Proj Bus 2019 course

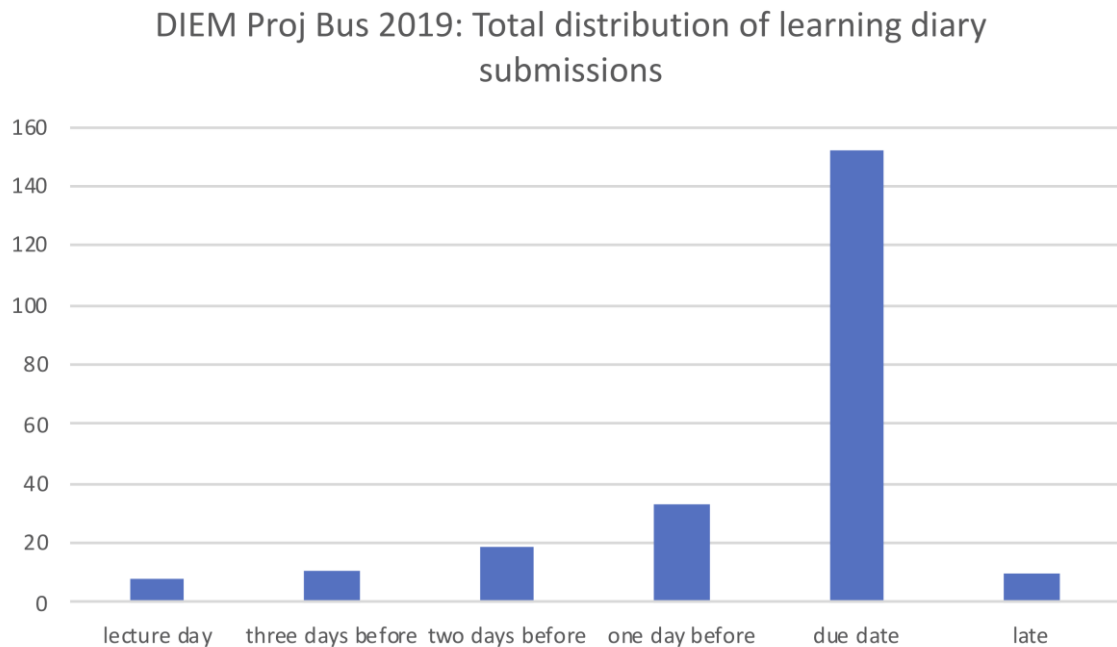


Figure 4 total distribution of learning diary submissions in DIEM Proj Bus 2019 course

DIEM Proj Bus 2019 course had a relatively strict window of submissions of learning diary. The lecture was on Wednesday afternoon and the deadline was Sunday at 18 PM. Because students had to give also feedback for each other's learning diaries the window was limited



for submissions. An overwhelming majority of the submissions were submitted during the due date of the submission.

DIEM Adv Proj Man 2018 had similar use pattern with lecture videos. The viewership of the lecture videos Studying on the course seemed to be focused on right before the exam. The course had lecture videos and they had almost all the viewership right before the exam. Even though there were some continual learning aspect and structure formed based on the lectures and cases they did not seem to translate to becoming to lectures or watch the lecture videos when they were published. Rather studying was focused on the last minute based on the information about lecture video statistics.

Overall DIEM Adv Proj Man 2018 structure encouraged students to have an approach of delaying studying. The exam had a high impact on the grade. The cases were intended to be done independently of lectures as they were pre-material for lectures. There are numerous possible reasons that lectures were not seen as valuable enough for students' time. Lectures not being interesting enough, students having conflicting schedule due to work or other courses, lectures taking a too long time, or students assuming that with lecture material and videos one could get the necessary information from lectures more effectively than participating. There was no other direct short-term benefit of being in the lecture than learning contents that were useful in the exam. This did not seem to be enough for the students to value participation in the lectures. The exam is a graded learning event that has links to over the whole course. The DIEM Adv Proj Man 2018 had an exam the main assessment method of the course and it is assumed that students participate in lectures and study the materials during the whole course so they would be most prepared in the exam. However, in practice, the video statistics indicate the students start studying right before the exam. The most minutes delivered in each lecture video were right before the first exam. The second exam had similar viewership spike as the first one albeit smaller one as there were fewer participants.

EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 had online modules as part of the course. The teaching staff allowed students to have the freedom to choose when the students would complete the modules. Red-thread modules were decided on a consensus basis in the EIT Digital to be the most important aspects in the program. This meant that some of the content in the modules might not necessarily be covered in the lecture parts of the course, some of the contents were complementary, and some were similar as with the lectures but

divided in the lectures around the whole course. Because there were no direct links between the materials in the module and lectures the course staff decided to give students the freedom to choose when they would study the modules.

Almost all of the students watched the online modules after classes and not before the lectures. Deadlines for multiple-choice quizzes were set for the end of the courses. Students seemed to treat lectures as an introduction and then deepen the knowledge in the online modules. Students also identified that connection between some of the topics and lecture content was varying.

Given the freedom to choose when the students would do the modules, the students chose to do them at a later date than trying to do them as preparation. Multiple-choice quizzes had also an effect on the final grade though there were multiple chances to complete them without penalties.

FITech Proj Man 2019 had tutoring sessions to help the students if they needed help during the weekly assignments. Assignments had the deadline set on Sunday. Tutoring sessions were available on both Wednesday and Friday afternoons. They were available as both walk-in session in Turku and via online chat. The tutoring sessions were throughout the course underused with only two instances that student came with a problem to the tutoring session. However, the discussion board would get questions during the Sunday evening about the assignment due the same evening. Even though the students had help available previously and knowledge of the timetables the students delayed the start of doing the assignment near the deadline and discovered late that they needed help.

### *Implications for teaching concerning students' strong deadline orientation, and developing Proposition 6*

Because of students concentrating the studying efforts right before the deadlines, the teachers have the possibility to structure the course that it demands students to study during the course whole. When students had the freedom to organize the studying effort as they wished most of the students seemed to delay the studying right before learning event or submission deadline. By setting a schedule that assignments have deadlines evenly during the course the teachers can guide the studying effort of the students to be more even than students would do when independently organizing studying.

We regard, that course structures such as deadlines, help those students that are willing to learn but have poor organizing skills for some reason. Course structures help students to manage their studying. If there are a lot of small tasks with clear deadlines, then it is easy for students to do assignments to that deadline and learn during the process. If there are only one or two big assignments the students that have challenges organizing their studying might start to study too late and it hinders their learning.

The deadlines of the assessments should be carefully considered and preferably deadlines should be distributed evenly during the course. As most students complete the assignments as the deadline grows near. Then placing most of the deadlines to the end of the course encourages students to delay studying until the last moment. If most courses have the deadlines similarly placed to the latter parts of the courses, the deadline-oriented students focus their study effort on a really short time. This might lead to an overall smaller time investment in studying than having more tasks evenly distributed. Large assignments should be handed as soon as the necessary prerequisites to complete the assignment is handed. Deadline does not necessarily be overtly long but rather relatively quickly with small buffer as most students will not utilize extra time at all to distribute the work. Another alternative could be to have midway returns for larger assignments, so students have also a chance to get feedback during the process.

Having multiple small assignments that demand completion supports learning by distributing the studying process of students over a larger period of time. This is an alternative for an intense learning session right before big learning event such as an exam. Teachers can acknowledge the deadline-orientation of the students and design the course in such a way that there are clear sub-goals that need to be completed in the course and in this way support learning.

Based on the above, we propose:

*Proposition 6 (P6): By increasing the amount of small graded assignments in the course curriculum which are scheduled with a steady rhythm, teachers can increase overall studying time that deadline-oriented students put into a course.*

#### 4.7 The role of feedback in a digitalized course

In this section, we present our findings relating to the role of the feedback with a course that relies on digital teaching materials. Students benefit from getting timely feedback during a course. The quick feedback helps students to improve their subsequent works by improving answering techniques and fixes possible mistakes in the thinking if these are present in the submission. On the contrary, slow feedback leads to dissatisfaction as students can have returned subsequent assignments with similar mistakes and this results in poorer grade as they could not fix the mistakes in their thinking.

Feedback supports learning in contact teaching, submitted assignments and in individually completed digital teaching materials. Teachers of the courses should take necessary steps to ensure that there are sufficient feedback opportunities during the course so the students can improve their thinking, answering techniques and correct possible mistakes. Feedback sources seem also being important. Peer-collaboration was not enough unless the authority figure like a teacher would wrap-up the discussion.

#### *Empirical observations from the case courses*

Feedback systems were observed and discussed in eight out of the eleven case courses. Feedback for assignments and feedback sessions in the courses where students received feedback and experiences about the feedback are in Table 14.

Table 14 Observations about feedback systems and experiences in the case courses.

Course	Feedback systems observed	Feedback experiences
DIEM Adv Proj 2018	Cases reviewed by staff. Focus on giving the feedback quickly. Students got feedback before returning next case. Students could spot mistakes in their thinking. Possibility to discuss the exam with staff afterwards.	One of the teachers had had bad experience on earlier iteration of the course with slow feedback. Their group had made similar mistake in two exercises that could have been prevented with earlier feedback.
DIEM Proj Bus 2019	Peer-review of the learning diaries. Reflection essay was graded by teaching staff.	Teachers had uncertainties of the capabilities of students to assess and give feedback for each other as the most students did not attend to lectures.
DIEM Proj Intro 2019	Feedback on three assignments.	No observations about feedback experiences.
Oulu Proj Intro 2018	No observations about feedback mechanisms.	No observations about feedback experiences.
FITech Proj Man 2019	No observations about feedback mechanisms.	No observations about feedback experiences.
FITech Marine Boost 2018	Iterative grading. Student gets feedback after first submit and an indication what should be improved to get better grade. This was applied to learning diaries and project works.	Teacher had viewpoint that iterative grading and feedback given during the process led to better results overall compared to exam. Revision process would allow students to spot mistakes and even apply them to past weeks.

FITech Naval Arch 2018	Exam based and the iterative grading style learning diary was missing.	Teacher felt that exam has problems due long feedback cycles. If there were mistakes in the exam the next chance to correct them is in two or three months. Delay in the retry would make it less likely that students retry and improve the grade outside failure.
EIT Digital Bus Intro 2018	Feedback on assignments (individual & group). Online-modules provided feedback when students had provided answers.	Students faced problems with modules. Some of the topics did not open to students when they watched the videos multiple times. They got less than satisfactory points from the multiple-choice quizzes. Long delay in receiving the automatic feedback made it hard to spot the mistakes made.
EIT Digital Bus Man 2018	Feedback on assignments (Individual & group). Online module automatic feedback released one month after course had ended.	
Bus Process Analysis & Man 2018	Students giving each feedback about case presentations. The feedback was graded.	Teacher felt that graded feedback assignment that students did during case presentation led to good conversation about the case that students benefitted from.
Elec Des in Eng 2018	No observations about feedback mechanisms.	No observations about feedback experiences.

FITech Marine Boost 2018 and FITech Naval Arch 2018 were part of a marine minor in the FITech. Overall marine minor emphasized the personal connection with the student. When a student enrolled in the minor program the staff would go through with the student what they should study to get the most out of the program. Some of the courses that were offered were highly technical and demanded necessary background knowledge from mechanical engineering while some of the courses would offer insight to marine business and could be taken with a business background. Different skillsets would be needed in the marine industry and marine minor would offer this introduction to the marine industry. Therefore, it was seen as vital to steer students to the right courses based on the background. Students would get the right courses and not disappoint if the course would prove unnecessarily hard due to missing background knowledge.

The personal connection was also extended to the feedback. This manifested as a process that was called iterative assessment which went as follows. Learning diaries would have a deadline. After the deadline students would get feedback on what was good and how to improve the learning diary. There would be preliminary grading and guidance what would be the improvement points to be achieved to get the highest grade. Students would then get one week to correct the lecture diary to get the better grade and learn what was a problem in the original submission. The same iterative assessment would also apply to the project works that were done in the courses.

Iterative assessment with learning diaries was seen as a better way to learn than the exams by the teachers. The quick feedback would expose the knowledge gaps in students learning

that could be corrected. Students would have the safety to explore options and to get feedback from them. Students would also see what the problems in their thinking and possible misunderstandings would be. However, the policy was to give extensive feedback only if students' effort was also fair. Lacking submissions would get feedback on what should be added. If a student had put effort into the submission, they would get feedback to improve their knowledge to the best possible standard.

FITech Marine Boost 2018 teacher felt that iterative assessment and feedback relating to this model was beneficial compared to the traditional exam-based assessment. Learning diary could offer continuous feedback loop that would allow students to correct their thinking. A similar effect with exam would be almost impossible to implement as there are two or three months before for the next exam possibility. Because of the long time between possibilities to try and improve there is a large threshold to participate to next exam possibility. Subsequent studying therefore limited in exam model compared to learning diaries with a shorter cycle.

The marine program had challenges with less motivated students during the second course. The students were really motivated during the summer boost courses and wanted to learn and improve their skills. During the second course, the less motivated students were seen as problems because they did not utilize planned learning events such as meeting times. There were demands for flexibility for course structure but in teaching staff perception there was little willingness to actually study. It was felt that those students used teaching resources but did not want to put the effort into learning.

Reciprocity was seen as important in the marine program. The teaching staff was willing to be flexible and offer time to give feedback and guide the learning of the students, but it was expected that the students would then put a lot of effort into studying. The effort would be appreciated and students that showed effort were offered guidance.

### *EIT Digital students view on feedback*

In EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 feedback was mentioned in the context of the online modules. As previously described the online modules had assessment attached to them. EIT Digital Bus Intro 2018 had feedback attached to them when answering. If a student had problems with a particular question, they would get instant feedback that would guide them to the right answer. The EIT Digital Bus Man 2018 did not

have this feature and did not provide feedback instantly. Each method had benefits and drawbacks. If the system did provide the feedback smart students could use the feedback to answer correctly almost right away, during their second try at a quiz. If feedback was not provided, then it was hard for students to assess where they had made their mistake and try and correct it.

If students got nearly full points on the tests there were no problems. However, when students did not get answers right there were problems. EIT Digital Bus Intro 2018 did provide feedback that allowed to reiterate the quiz and get full points. During EIT Digital Bus Man 2018, there was no such option. If something was left unclear, then students felt that there was little or no chance to get easily more information. Videos and material did not open for students even though they were re-watched. There was no chance to get information about what went wrong in their thinking. Correct answers were released eventually to students but that was after Christmas break and new courses had already started.

The way that online modules was organized were challenging for learning. As the students were able to do them after classes most chose to do tests at later stages of the course. If after watching videos there were knowledge gaps students could not address them easily. There was no additional material referred to in the modules that students could use to look right answers.

### *Implications for teaching concerning feedback when students use digital materials, and developing Proposition 7*

We regard that teachers should ensure that there are good feedback mechanisms during the course. The benefit of continual assessment during the course is that there are multiple points to give student feedback about their learning progress. Quick feedback helps students to learn for subsequent assignments. Prompt feedback also gives students a chance to correct their possible misconceptions before those get rooted in their thinking. Feedback gives an indication for a student what are topics that require more studying, and which are sufficiently covered.

Feedback should also be present during the teaching events. If there is a group discussion or some assignment there should be a summary that connects the discussion or assignment together. This gives students validation for correct ideas and corrects possible misconceptions. Group discussions and classroom assignments are a good way to explore a

topic and apply knowledge. The summary at the end of group discussion or classroom assignment gives information about alternative ways to approach the topic of classroom assignment or discussion.

There should be personal contact with the students if the students desire to have contact. This can be arranged through a meeting during contact teaching in person. Then students can ask questions during or after the teaching event. Giving feedback in person also allows better contact and the possibility to answer questions than via text.

We regard that teachers should put effort into ensuring that there are good feedback mechanisms during the course. The feedback that is quick, precise and continuous during the course support the learning. Teachers should give enough time to give written feedback. Contact teaching should also have situations that teachers draw conclusions from the discussion and correct possible misconceptions. Digital teaching materials can be used to transfer some of the teacher's effort in the course from lecturing to giving feedback for example form of discussion in the lectures or allocating some of the lecturing time to provide quick feedback on assignments. Distance teaching courses should ensure that students get sufficient feedback during the course.

Based on the above, we propose:

*Proposition 7 (P7): By decreasing the time between a student completing a digital assignment and getting feedback, teachers can decrease misconceptions that students might get from digital materials.*



#### 4.8 Role of active learning in a digitalized course

In this section, we present our findings on the use of active learning when using digital teaching materials. However, we argue that active learning benefits both the use of digital teaching materials and traditional teaching, so we present our findings of both. We observed that the students pay more attention than students that only have to passively observe when they have a task that they need to complete. During long lectures where students only had to listen and passively observe the teaching, led quickly to situations where more and more of the students started to look at their laptops and mobile phones rather than paying attention to the lecture. Also, we observed that the long videos had a similar effect and it was better to give students tasks to do during the watching so they would pay more attention. When students had a task, they exhibited a longer attention span than when having no task.

##### *Empirical observations from the case courses*

We observed that passive participation had an effect on the attention level in some of the case courses. Case courses that utilized videos in their teaching also employed some method to make students pay more attention during the watching of the video such as multiple-choice quizzes afterward. Collection of observations in the courses is in Table 15.

Table 15 Observations about active learning in the case courses.

Course	Observation
DIEM Adv Proj 2018	A lot of participating students to lectures at the same time multitasked with laptops and phones instead of paying full attention to the lecture.
DIEM Proj Bus 2019	No observations about the effect of student activation.
DIEM Proj Intro 2019	Use of multiple-choice quizzes to motivate watching videos.
Oulu Proj Intro 2018	Use of multiple-choice quizzes to motivate watching videos.
FITech Proj Man 2019	Use of multiple-choice quizzes to motivate watching videos.
FITech Marine Boost 2018	No observations about the effect of student activation.
FITech Naval Arch 2018	No observations about the effect of student activation.
EIT Digital Bus Intro 2018	Multiple choice quizzes were meant to activate students during the online modules. Students opinions differed if the activation was successful. Some said that it made them pay more attention and make notes during the videos. Others saw that additional job that did not affect learning.
EIT Digital Bus Man 2018	
Bus Process Analysis & Man 2018	Feedback during case presentation made students more active while listening and started good discussions afterward.
Elec Des in Eng 2018	Students did not reflect on the animated videos in the learning diaries and did mistakes that could have corrected by watching videos attentively. Animations could be discussed in class or have a quiz attached to them according to teachers as a possible activating method.

DIEM Adv Proj Man 2018 had low participation rates during lectures. To compound the problem of low participation the participating students engaged in multitasking in the form of focusing on their laptops or phones during the lecture. This meant that there were few students that participated in lectures and when there used the learning event as intended.

ELEC Des in Eng 2018 used the animations to teach methods that designers use in a design process. The analysis based on the animations was mostly missing from the learning diaries according to a teacher. Design processes also suffered from the mistakes that could have been prevented by the methods mentioned in the videos. One possible solution offered by a teacher would have been to assign task more clearly with the animations. This would increase the attention paid to the animations instead of them just being watched. Another possibility the teacher discussed was to utilize short animations in the class and have a discussion about methods to drive the point in the students.

Bus Process Analysis Man 2018 observed that giving students a task to write feedback during the presentations made the students actively follow the other groups' presentations. This also resulted in a lively discussion about the case presentations afterward. The feedback that students were required to give was a small part of the case grade. This also further encouraged the students to participate by following presentations and give good quality feedback to presenters.

EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 had multiple choice questions dealt with questions that were directly from the videos. Students saw this as somewhat problematic. Some topics were seen as explorative and having no clear answer and questions were somewhat perceived to be such – to have multiple possible right answers depending on the context. However, what was asked in the questions was to reiterate what was in the videos. Style of the questions was more to ensure that videos were watched than to test students' understanding of the topic. Some of the students saw this as a problem and would rather have questions that would test understanding of the topic and capability to apply knowledge than memorization of certain questions.

Some of the online modules, that were in the EIT Digital Bus Intro 2018 and EIT Digital Bus Man 2018 courses, had several hours of videos but only ten questions in the module. There was a disparity between the amount of the videos that student needed to watch and the amount of the questions that they had to answer. One of the interviewed students expressed

distraught that they had watched four hours of videos and then afterward the questions asked very specific details that required them to search the right spot from the videos to answer correctly. The student afterward decided that they would not watch the next online module and videos in it first and then try to answer the quiz, but rather watch and do the quiz simultaneously. The student felt that the correct way would have been to watch the videos first and then to answer the quiz, but the questions encouraged the student to do watch the video and do the quiz simultaneously. The student decides next time to have the quiz open at the same time while watching the videos and encouraged the fellow students to do the same.

Though the multiple-choice quiz employed in the EIT Digital courses was activating the students the method utilized was sharing the opinions among the students. The positive opinions mentioned that it helped to identify key concepts, make them to take notes and to check what they did not understand yet. Those that would have preferred not to have quizzes saw that they were hindering the learning. They thought that those were a thing to finish and transfer focus on passing the test. The students also saw that the disparity of the amount of the videos that student was required to watch was a hindrance to activation with students. Also, they did not consider helpful that questions were separated from the videos but would have wanted questions to be directly after the videos.

### *Observations from contact teaching in DIEM*

As to get an overview of traditional teaching, we participated in the DIEM lectures as a participant. Following observations are from these courses and not directly linked to any of the case courses. Most of the DIEM lectures and teaching sessions were that we participated in were relatively long. A standard lecture at Aalto University is two hours but a standard in the Industrial Engineering and Management Operations and Service Management sessions that we participated in the observation period courses seemed to be 3 hours or longer. There were few breaks during the lecturing. Usually, there was one long break that was about 15 minutes.

Some of the teachers used different ways to activate students during lectures. These methods included small group discussions and posing questions for students. During observed lectures, these were mostly implemented at the start of the lecture. The discussion was at the

start of the lecture about pre-reading materials but then there was little activation during the rest of the lecture.

Most of the observed teaching events had a very teacher-centric approach to contact teaching. Even though there were some group discussions most of the time of lecture was used for information transfer from the teacher to the students. This teacher-centric lecturing is the norm and safe ground that is comfortable for both the teacher and the students.

Lectures offer the possibility of interaction between students and teachers. Students have the possibility to pose questions to the teacher is seen as one of the benefits of the lectures. However, in practice, few questions are asked during the lectures. Also, the lectures that have group discussions and discussion among the class suffer from a similar problem. Discussion during small groups is lively. However, when asked to share thoughts with a larger group the discussion is limited to a few individuals.

During lectures and teaching events reducing the student to passive participant lowered students focus that was directed to follow the teaching. On the other hand, when students had to be active such as during group discussions, classroom assignments, and interviews the attention level was higher than in the passive observing parts of the lectures.

During long lectures and passive observation, the attention of the students tends to wander away from the taught topic. One great example of the focus of the attention was in one exercise session. Their students interviewed in groups panel of experts about a process. Students job was to map the process. Each student group was in charge of one part of the process where they had to be conducting the interview and mapping the process. However, their task was to map the whole process for a written assignment based on their part of the interview and other group contributions to mapping the process. During the first group (first 40 minutes of the session) attention of the observers was high and they observed the interview. However, during the second group, passive observers started more and more to divert their attention to laptops and mobile phones. Students that were on the stage were fully committed to the task but when off the spotlight the students quickly lost interest in following the interview even though it might have been helpful for writing the report later.

“It is somehow easy to attend [to the lecture]. Something always sticks in your mind.” was a student quote heard during one of the observations. The statement expresses the attitude that student can participate in a lecture and some knowledge sticks whenever the student

pays attention to a lecture or not. We argue that participating students should direct their attention to lecture and lecturer in response to structure their lectures so that students get enough sections that demand active participation that keeps their attention high.

*Implications for teaching concerning the use of active learning when using digital materials, and developing Proposition 8*

The independent study with digital teaching materials demands to activate students. If the digital teaching materials such as videos are just presented for students, they might be watched or otherwise used for studying but only on a surface level. Linking activating tasks with them make students spend time with materials and think about them more deeply which encourages materials are learned.

Similarly, lectures and contact teaching should use active methods. The longer contact teaching is passive listening the more students divert their attention to somewhere else. On the other hand, if there is a clear task to for example observe something from a video, knowing that there is a group discussion and afterward students should be able to present some results the attention level of the students is completely different.

Learning events needs to be structured that student is active during the learning events. This concerns both digital teaching materials and more traditional contact teaching events. By having student active and processing the information presented the information is processed more deeply. Passive participation often leads to multitasking and multitasking hinders focus on the learning task.

This does not mean that lectures should only contain discussion and there is no room for information transfer. The lectures and digital materials should be balanced with activating sessions and be situations where the student has to only passively observe should be kept short and use sections where students are activated due question or discussion to rhythm the learning event.

We argue that having students active during learning events improve learning by having them being more focused on the task. Students keep more attention if a task is activating them during the learning event. This activation during learning event can be a discussion during a lecture, having students to consider question during watching a video or requiring a student to write learning diary about the learning event. Students need to consider how the

information is connected to learning topic or seek an answer and this keeps students' attention more on the task than passively absorbing information.

Based on the above, we propose:

*Proposition 8 (P8): By giving problems and questions relating to digital materials for students to solve, teachers can increase the students' attention on digital materials.*

## 5 Discussion

We established the theoretical background for this thesis in the sections 2.2 Use of digital materials in courses, 2.3 Blended teaching, and 2.4 Flipped Classroom. These form the current practice-oriented research results that offer perspectives on how to use digital teaching materials by themselves and how to organize course structure with the help of digital teaching materials. In section 5.1 Relating the eight propositions to existing research, we connect our propositions to existing research. In section 5.2 Distinguishing central areas and considerations of discipline integration, we use our propositions and findings to elaborate the connections between the three different areas of research: Use of digital materials in courses, blended teaching, and flipped classroom.

### 5.1 Relating the eight propositions to existing research

Proposition 1 (P1) is:

*The increase of conciseness and inspiring content in educational videos increases the students' active use of videos for self-study.*

Regarding P1, we observed that in many of the case courses such as DIEM Adv Proj Man 2018 and DIEM Proj Bus 2019 the students did not watch long lecture videos, but short videos were watched. EIT Digital students wished that videos would either be faster pace or have an ability to control the speed. Oulu Proj Intro 2018 had several iterations of lecture videos. During this iteration process, they transformed the videos from recording lecture to short videos that contained only certain aspects of Project Business. P1 reinforces similar findings by Brame (2016). Conciseness of the videos contributes to better viewership as demonstrated by empirical material. The inspiring presentation was also found in the empirical material as an important finding because otherwise, students tend to wish for the possibility to speed up the presentation.

Proposition 2 (P2) is:

*Specialized digital material development function external to course organization facilitates cross-course fertilization and learning at the school level and thereby advances the overall culture of use of digital teaching materials.*

Regarding P2, all of the case courses but the Bus Process Analysis Man 2018 had support from external organizations to start using digital teaching materials. FITech, Aalto University via A!OLE, EIT Digital, and Oulu University all supported the courses to start using digital teaching materials. The reasons and drivers differed but all organizations supported the use of digital teaching materials. Bus Process Analysis Man 2018 was unique that it did not have other support than the resources to organize the course. However, the teacher of Bus Process Analysis Man 2018 had previous experience from another university of using the digital teaching materials. As the teacher had received support to start use materials previously, the teacher was more inclined to use digital teaching materials in their teaching. The support and the push from the organizations contributed to the adoption of materials in the course. Lean et al. (2006) and Harley (2007) indicated that the teachers would use digital teaching materials if it fitted to their pedagogical style and averted them if not regardless of the support. In our context, there was both support of producing digital teaching materials and demand from the outside for digital teaching materials. It is possible that only teachers that were open to experimenting with digital teaching materials were chosen to teach courses with digital teaching materials. The teacher's predisposition could have an effect on the chosen forms of digital teaching materials. However, the support of the production contributed to the practical implementation of the materials. The support in production resulted in better quality and faster implementation of the digital teaching materials compared to the self-taught method. Also, when teachers had experience of using digital teaching materials, they were more open to implementing digital teaching materials in subsequent courses.

Proposition 3 (P3) is:

*Increasing the accessibility of the teaching materials by transferring them into digital format enables teachers to increasingly require that students are acquainted with the materials in their self-study time. This increases further preparedness of students coming to contact teaching events.*

Regarding P3, the most cited benefit of the digitalization of the teaching was that the digital teaching materials offer scalability. Elec Des in Eng 2018 teacher viewed that digital teaching materials offer scalability that eases the workload of the teacher during the courses. EIT Digital saw that the scalability as a benefit as courses in other European universities that participate in EIT Digital could use the same online modules. Even though it was cited as



the benefit of the actual examples that videos would be adopted by another teacher that was not in the process of making them were limited to EIT Digital. Another often cited benefit was accessibility that was observed in EIT Digital and Oulu Proj Intro 2018. Some of the case courses such as EIT Digital and DIEM Proj Intro 2019 used the lessened need to use contact teaching time to go easily internalized contents, to use contact teaching time for questions, discussions or other learning contents. Accessibility in the study reinforces similar observations from Henderson et al. (2015). They found the benefit of digitalization being the easier logistics and our findings collaborate that one benefit of the digital teaching materials was the ease of access. Harley (2007) noted that the teachers preferred to make the materials by themselves. Our findings reinforce that notion somewhat as if there was no pressure from the parent organization to have similar teaching materials the teachers would mainly use the material, they produced by themselves if possible.

Proposition 4 (P4) is:

*Students' studying efforts on digital teaching materials can be planned to affect students' effort by making particular tasks, exercises, and assignments to contribute to the overall grade.*

Regarding P4, we observed that completion rates of the learning events where grading was attached were higher than the learning events where was no grading. EIT Digital courses had both optional and mandatory online modules where the mandatory modules had much higher watch rates even though the optional modules had also content that was part of the learning outcomes of the whole course. DIEM Adv Proj Man 2018 had high completion rates of case assignments and exam but optional learning events such as attending to lectures had low participation even though it might have been beneficial for students to attend those. The finding that students value learning events that award points towards grade have had similar indications in the research. Motivating effect of the grade for lecture participation in hopes that increased lecture participation also increases tests scores has been under research (Baum & Youngblood, 1975, Hancock, 1994). These studies found that awarding points or penalizing missing learning events had an impact on participation and also effect on exam performance due to increased participation. Similarly, our empirical study shows that teachers share the notion that graded learning events can be used to increase participation, for example, Bus Process Analysis Man 2018 had graded learning events in the lectures to motivate students to participate such as presentations and simulations. Bus Process Analysis

Man 2018 also had lectures that did not have any tasks that This reinforces the of the research of the flipped classroom where introducing graded element for pre-materials increased the preparedness of the students (Bishop & Verleger, 2013). Our empirical study reinforces insight that graded learning events increase students' motivation to complete learning events.

Having the grading as a mechanism that steers students' attention is a powerful tool. The question is if the participation in the learning event then translates to learning. The previous research heavily relies on examining the exam results or quizzes during the course (e.g., Baum & Youngblood, 1975, Hancock, 1994, Shimoff & Catania, 2001). All of these studies found that increased lecture attendance increased the exam results. Shimoff & Catania (2001) demonstrated that increased participation helped students with material that was not covered in lectures. The important question is the quality of the learning events and if the learning events contribute to students' learning. The grading increases the motivation to participate but equally, important thing is to ensure that the learning event also contributes towards learning the topic.

We regard that the benefit that students received from the learning events is the key point. The grading attached improves the participation and completion, however, the learning event needs to be something that needs to contribute to learning. The focus on exam scores as a measurement of learning leads to a poor chain of reasoning. If we, for example, give points for participating in lectures and that leads to better participation but a marginal increase in test scores, then the focus should be to improve the lecture to encourage learning. Because there is little benefit in learning based on the exam scores is not a valid reason to disregard the increased motivation to complete the learning events but to turn focus that the learning events are beneficial for the students.

Proposition 5 (P5) is:

*Studying of non-graded digital materials can be increased by connecting non-graded material to an assignment that demands the studying of the material.*

Regarding P5, the DIEM Proj Man Intro 2019 and other similar intro courses to project management used the multiple-choice quizzes to have students go through a book and video material. However, the DIEM Proj Bus 2019 also had an example of P5 but not as successful. DIEM Proj Bus 2019 had learning diaries that were supposed to be done based on pre-lecture materials such as videos and pre-readings and lecture content. However, as the lecture

participation was not mandatory, most of the students did not participate in lectures especially during the latter parts of the course. The use of graded learning events to have students study prior materials was something that was also suggested by research about flipped classroom (e.g. Bishop & Verleger, 2013). Use of quizzes to tests the pre-materials was noted as good practice. We found that the graded linked learning events increase the studying effort of the linked material and learning events but do not guarantee the use. Having graded learning event to motivate watching or participating to learning event that deals with the same subject are a preferable solution to having no such assignment or quiz, but it does not guarantee the participation to a previous learning event. The focus should be on designing the linked learning events and that the graded assignment demands suitable knowledge acquisition from the other learning events that the students gain the wanted learning outcome from the linked learning events. Recognizing that having linked learning events is not by itself guarantee to have full participation is a new contribution to research.

Proposition 6 (P6) is:

*By increasing the amount of small graded assignments in the course curriculum which are scheduled with a steady rhythm, teachers can increase overall studying time that deadline-oriented students put into a course.*

Regarding P6, students' response to schedules of learning activities seemed to be deadline-oriented based on the empirical study. DIEM Proj Bus 2019 student learning diary submissions were on time. However, the vast majority of the submissions were returned during the submission day. Similarly, pre-material watching had a viewership spike during the deadline days. EIT Digital allowed students to choose when they would do the online modules. The vast majority of the students opted to do the online modules at the end of the course. Student deadline orientation is contrasting on the views of the ideal Finnish student that Kangasniemi & Murtonen (2017) constructed from the views of the university personnel. The ideal student might be self-pacing, but empirical material shows that students delay the return of the assignment towards the end of the deadline and similarly delay the watching of digital teaching materials right before the linked learning event. The idea of an ideal student does not seem to correspond with reality. Teachers should take this into account when structuring the courses. By acknowledging that most of the students do not represent the ideal that university personnel imagines, the courses can be structured to support more deadline-oriented students rather than leave them on their own accords. The results that

students are deadline-oriented seem to be more in accordance with Pajarre (2012) where students wanted more support from the structures. A course designed that there are multiple manageable assignments with deadlines could offer support to those that are deadline oriented to study more evenly than with a completely free model. In this study, we observed the deadline-oriented approach in many of the case courses so this finding did not seem to be due course circumstances that would have pushed students to limits but a larger phenomenon that students are deadline-oriented.

Proposition 7 (P7) is:

*By decreasing the time between a student completing a digital assignment and getting feedback, teachers can decrease misconceptions that students might get from digital materials.*

Regarding P7, observation from the FITech Marine Boost supports the P7 as teachers felt that students learned better when they had learning diaries and got feedback before every submission, compared to the exam where similar feedback loop did not exist. EIT Digital students wished that they would receive feedback from the online modules and felt that it hurt their learning as they received the feedback very late. Both Karppinen (2005) and Laurillard (2002) mention the feedback. Though the form of the feedback and where the feedback is received seem also important based on the empirical study. Karppinen (2005) mentions peer-collaboration, facilitating discourse and direct instruction. The empirical study emphasizes the need in the last two even in case of peer-collaboration to correct the misconceptions and give verdict if students have understood the topics correctly. Laurillard (2002) focuses more on the correcting misconceptions part of the feedback. This thesis affirms the need for feedback to correct possible misconceptions but also puts emphasis on the authority figure of the teacher and need for approval from there. Another contribution to the subject of feedback is the need for timeliness and continuity. These help the learning by having possible mistakes fresh in mind and the possibility to correct them quickly and ensuring the motivation to keep learning and improving.

Proposition 8 (P8) is:

*By giving problems and questions relating to digital materials for students to solve, teachers can increase the students' attention on digital materials.*

Regarding P8, ELEC Des in Eng 2018 had an observation that if students did not have to reflect on animation videos, they did not learn the lessons that those animations concerned. Active learning and student activation are found in the empirical study as well as on the theoretical background. Active learning also affected both on the digital teaching materials and general teaching and learning (e.g. Freeman et al., 2014, Brame, 2016). While literary suggests that active learning improves the learning by having students constructing mental connections and therefore having a lasting impact, we add an additional factor of active learning making students more task focused. Empirical observations lead us to conclude that students kept their attention more on the task when they had to actively do something compared to passive listening. Passive participation leads to quickly to multitasking which makes the learning problematic. By having students actively participating they are more focused on the learning event. We add this increase in concentration as an additional benefit of active learning as the improvement in the cognitive process.

## *5.2 Distinguishing central areas and considerations of discipline integration*

Our empirical research addressed the use of digital teaching materials and also how to integrate those into courses overall. It also observed case courses taught in different modalities: contact, blended, and distance teaching. The findings of our empirical research fall into three different kinds of literature: the use of digital teaching materials, blended teaching, and flipped classroom. In this way, the empirical research bridges these three kinds of literature by integrating partly their inherent disciplines. Research on these topics have partial overlaps but each has differing aspects that the research area addresses in teaching.

Research on the use of digital teaching materials deals with teacher's and student's use of those materials. Blended teaching focuses on how different modalities of teaching (contact teaching, blended teaching, and distance teaching) should be used for teaching. Flipped classroom as a popular way to organized blended teaching focuses on the practical questions and effectiveness of organizing teaching. Flipped classroom works as flipping the paradigm of information transfer in the classroom and exploration independently to first information transfer independently and then exploration in the classroom. The digital teaching materials are a popular tool in blended teaching and flipped classroom to deliver the information, but the research focus is different in all of these disciplines. The scope is different when comparing the use of digital materials to blended learning and flipped classroom. Use of digital materials deals mostly with singular subjects such as student or teacher and how

digital materials affect them while blended teaching and flipped classroom deal with the whole course and participants in courses. Flipped classroom deals with specific challenges and solutions in one form of blended teaching while blended teaching is more general about different modalities and their benefits.

Our three first findings deal with the production and benefits of digital materials (See P1-P3). We found that shorter and inspiringly presented videos are more used than longer videos (see proposition P1). The length and presentation of the video materials should be considered if videos are chosen to be the method of information transfer in blended teaching and flipped classrooms. The second finding is that external functions that help to spread the culture of using digital materials within higher education (see proposition P2). This elaborates the culture shift that is necessary if successfully trying to introduce the digital materials in teaching with blended teaching or with the flipped classroom. The third finding is that digital materials provide access to materials which can be used to demand that students get acquainted with materials in their own time (see proposition P3). It bridges all three research areas together by explaining why the digital materials are useful in the blended teaching and flipped classroom.

The findings suggest ways of integration between the student's use of digital teaching materials and organizing course that uses digital teaching materials (see propositions P4-P8). Grading and assignments can be used to ensure that students engage in studying digital teaching materials (see propositions P4 and P5). By having graded assignments that demand the studying digital materials, teachers can ensure that students use the digital materials and are ready for contact teaching. This clarifies how to use digital teaching materials and how to structure course as dealt in the flipped classroom. Having a strict course schedule with small continual assignments to rhythm the student's studying effort ensures that the student spends sufficient time to study materials (see proposition P6). Importance of the schedule of the course combines the research disciplines of blended teaching and flipped classroom. P6 clarifies them by explaining how teachers can make the students to use individually studied materials during the whole course. It is important that students get feedback on how they understood the digital materials (see proposition P7). This proposition combines the knowledge about the pitfall of digital materials (if students do not understand the digital materials watching them, again and again, makes little difference) and how to organize the course to correct the pitfall. One of our findings suggests the importance of active learning when using digital materials (see proposition P8). This elaborates and combines the

knowledge in the use of digital material to use in the courses to ensure that pre-materials are understood (blended teaching and flipped classroom).

Overall, we elaborated the knowledge of the specific research areas. By looking at the different areas of research, we could clarify the connections between the different disciplines that deal with the use of digital teaching materials in higher education. The empirical research concerning the use of digital teaching materials in courses bridges the prior research by looking case courses in a holistic way and by deriving the propositions that connect different disciplines.

## 6 Conclusions

### 6.1 Contributions

This thesis derives eight main propositions (P1-P8). Propositions P1-P3 are specific for use of digital teaching materials while the author argues that the P4-P8 apply both for use of digital teaching materials and traditional teaching. These eight propositions contribute to the research on the use of digital teaching materials, blended teaching, and flipped classroom. These also elaborate connections between those three research areas. The propositions and contributions of propositions are the following.

*P1: The increase of conciseness and inspiring content in educational videos increases the students' active use of videos for self-study.* The increase of conciseness and inspiring content in educational videos tends to increase the students' active use of videos for self-study. Digital materials are different medium than traditional mediums and they demand suitable presentation for being effective. P1 reinforces the findings of the best format of videos (Brame, 2016).

*P2: Specialized digital material development function external to course organization facilitates cross-course fertilization and learning at the school level and thereby advances the overall culture of use of digital teaching materials.* Support in the production of materials results in better quality materials and give teachers framework and ideas of how to use digital teaching materials in their own teaching. These lower the threshold to use digital teaching materials in their teaching. P2 contrasts the findings that teachers only adopt the materials if suitable with pedagogical style (Lean et al., 2006, Harley, 2007).

*P3: Increasing the accessibility of the teaching materials by transferring them into digital format enables teachers to increasingly require that students are acquainted with the materials in their self-study time. This increases further preparedness of students coming to contact teaching events.* Teachers view that digital teaching materials enable teaching larger groups. Another benefit is seen that students can access the material better than before due to digital format. These can be used to decrease the need for contact teaching and depending on the course either use contact teaching for exploration of harder learning contents or decrease the amount of contact teaching. These reinforce the findings of accessibility (Henderson et al., 2015) and scalability (Harley, 2007).



P4: *Students' studying efforts on digital teaching materials can be planned to affect students' effort by making particular tasks, exercises, and assignments to contribute to the overall grade.* Students seem to value and focus their efforts on learning events in the course that affect the grade. P4 reinforces the notion that graded assignments motivate students to participate in teaching (Baum & Youngblood, 1975, Hancock, 1994).

P5: *Studying of non-graded digital materials can be increased by connecting non-graded material to an assignment that demands the studying of the material.* Students study more materials that are needed to complete an assignment, but it is not guaranteed that they utilize the material fully. P5 reinforces and adds how to motivate students to study pre-materials (Bishop & Verleger, 2013).

P6: *By increasing the amount of small graded assignments in the course curriculum which are scheduled with a steady rhythm, teachers can increase overall studying time that deadline-oriented students put into a course.* The students are deadline-oriented and often do studying at the last moment. This leads that the studying happens right before the course mandated deadline. P6 contrast the view of the students in Finnish universities being active and self-motivated (Kangasniemi & Murtonen, 2017) and reinforces that students need stricter course structures (Pajarre, 2012).

P7: *By decreasing the time between a student completing a digital assignment and getting feedback, teachers can decrease misconceptions that students might get from digital materials.* Students benefit from quick feedback while delayed feedback hinders their learning. P7 contrast that peer-feedback is sufficient with digital teaching materials (Karppinen, 2005) and reinforces the views for teacher provided feedback (Laurillard, 2002).

P8: *By giving problems and questions relating to digital materials for students to solve, teachers can increase the students' attention on digital materials.* When students have to actively work on the task, they are less likely to start multitasking and this leads to a better learning event. P8 reinforces that active learning is better than passive observation for students to learn (Freeman et al., 2014).

## 6.2 *Pedagogical implications*

When the courses are redesigned, new possibilities offered by the digitalization of the teaching should be taken into consideration. New tools can offer the possibility to do organize the course differently and allow the teacher to participate the learning in other ways than to transfer the information for students by lecturing. However, as all redesigns, this takes time. It might be even more time consuming if the teachers need to learn new skills to present in the videos or to produce other forms of digital material. Therefore, it should be done iteratively to train teachers to apply digital materials. When there is enough knowledge to produce the materials for courses are acquired then larger productions can be made.

The benefits of digitalization (scalability, reachability, no need to reserve contact teaching for information transfer) of the courses compared to the time and monetary costs that digitalized courses demand give the best benefit in the bachelor's program courses. Digitalization, production of contents and videos take time. It would be better to put effort into courses that change less than quickly evolving courses. Basic courses have more participants than the advanced courses that are taught more in the master's level. So, if universities want to teach more responsible methods of working, preparing for contact teaching, and critical thinking it would be best to start with new students to universities, so they get a better way of working from the start.

If basic courses are digitalized there still should be a strong presence of professors and other staff to ensure that contacts between students and faculty forms. This presence in studies could be organized with exercise sessions, discussion seminars and so on that would still get the interested students in one place to ask questions about the difficult topics, get help to apply the knowledge that is given in the digital teaching materials.

Larger courses such as bachelor's courses that teach the fundamentals of the subjects can have higher production value videos produced to them. Large bachelor's courses that have fundamental topics that do not change can have the largest benefit from videos. Digital materials offer flexibility to study without a certain timeslot. In bachelor courses there are most viewers for the videos and those can benefit from the better quality.

Smaller courses can also be digitalized and utilize materials that have been produced. The video production equipment for simple videos is more and more available which means that production costs for simple quality videos are only the time that is used to produce them. It

might be worth it to produce materials in digital form to use more time during the master courses to feedback, discussions, cases, and assignments.

We consider that course curriculum should have an emphasis on where students get their grades. Teachers should use grading as a motivational tool to steer students' efforts during the course. As students see that certain learning events contribute to the grade, they change their behavior and complete the required learning events in high percentage. Course staffs should take this account when structuring their respective courses.

Based on the empirical material it would be the best way to award points directly from the most valuable learning event and not to rely on the linked events if just participation gives the best effect. However, in practice, this might have problems such as how to ensure if videos are watched with a thought if the grade is rewarded for the watching. In this case, other learning events such as assignments need to be employed. In this case it the focus should be on the form of the assignment and that it engages the students to study linked materials. An additional challenge comes from students that might not be suitable judges if it would be beneficial for them to participate in learning event or not for correct learning outcomes.

The learning events that contribute to grades need also special emphasis that they demand the studying and reflection of the linked materials. The graded learning events should also correspond to the amount of the materials. If there is a lot of material it should be covered with tasks that are closely related to material and frequent rather than only a couple of huge assignments in the course.

Structuring the course that there are multiple assessed tasks that link to materials also provides a possibility to offer feedback and guide students during their learning process. The emphasis should be put to feedback, so students have chances to get indications of what possibly goes wrong or indication that they are on the right track. With quick feedback, students can remember what happened with the tasks and can identify mistakes. They can correct their thinking as a result, and it can show a better grade in the same course. An alternative is long feedbacks with a course structure that does not encourage students to improve but to rather forget the bad grade.

### *6.3 Validity and reliability considerations*

We took many steps to ensure that the thesis and its findings are both valid and reliable. To ensure the internal validity of the study we used multiple sources and viewpoints where we triangulated the findings. We interviewed multiple teachers and students during the thesis to gain views about the use of digital teaching materials from both teachers' viewpoints and students. These were complemented with observations of lectures and seminars, conducting a survey, student feedbacks on courses, written information about courses such as grading principles and instructions to students, course design meetings, course participation data, and participation in educational video series production. From these different data gathering methods, we got a rich body of data where findings could be drawn and checked that they are supported by different viewpoints and not just relying on one singular source.

External validity and reliability of the findings are ensured by carefully describing the context and case courses where the data was gathered. By knowing the case courses and their context the readers, practitioners, and researchers can assess if the contexts are similar enough for the findings are applicable in their context. We also chose differing contexts for case courses to increase the external validity of the findings by avoiding a really narrow context where results would be valid. By presenting the methods and contexts of the thesis there is enough knowledge to replicate the study and to ensure the reliability of the thesis.

We ensure the confirmability of the findings by transparently presenting the connection to actual data. The case-course examples are richly detailed in the findings section and with comprehensive tables about describing the connection between empirical observations on each case course under each finding. The whole process is also detailly and transparently described from the data gathering to data analysis.

### *6.4 Future research avenues*

The findings of the thesis lead to several avenues for future research. An interesting aspect of the study was that teachers had a view that videos were scalable in teaching use. However, the teachers offered little examples of using other videos than own productions in their teaching. Further research could focus on how to make digital teaching materials scalable in a way that other teachers can start to use materials in teaching and how to transfer digital teaching materials to other courses.

Graded learning events do not guarantee the use of linked learning events. The research could focus on the subject of what is the corresponding way for the learning events to link together. Which are suitable assignments for which type of learning events that teachers want the students to focus on? By researching ways to connect tasks together for example information transfer in the form of videos and lectures to assignments like learning diaries we could help to establish best ways to encourage students to study all parts of the course.

We found that a sizeable majority of students are deadline-oriented in their studying. Further research could focus on its efforts to find out how teachers can best use this deadline orientation to make students study. Some of the case courses such as DIEM Proj Intro 2019 used quizzes to rhythm the studying pace of the students. Further research could focus on how to rhythm the students studying, and which kinds of assignments and learning events are the best way to establish a good pace for students.

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## 8 Appendix A: Student Interview Structure

### **Background:**

- Could you tell a bit about yourself and your background?
- Do you have previous experience on courses that utilized blended learning/online learning?
- If so, how they were organized?

### **Course overall:**

- Could you describe how your study process was on the introduction to digital business course or digital business management? When did you do online modules? When did you do the tests?
- Why did you organize your studying this way?
- How the lectures and online modules linked together from your perspective?
- Did those support each other or not?
- Did the course that was organized this way allow personal contact? Was it easy to approach course staff if it was necessary?
- Did the online modules and contact learning allow better or more intense learning as they were currently organized?

### **Online modules:**

- How did the videos affect your studying?
- How would you describe videos? Interesting, boring? Were there a lot of variation in those?
- Did videos raise a lot of questions or generate interest?
- Would you rather have another way of studying? Reading articles or book?
- Why is that?
- What did you think about being able to study at your own pace?

### **Videos:**

- Did you watch optional videos?
- Why did you watch the optional videos?
- When did you watch those?
- Did those offer interesting perspectives in addition to mandatory ones?
- Role of the optional videos? Beneficial, interesting, helpful?

### **Tests and quizzes:**

- Tests and quizzes how did they impact on your studying?
- Why?
- Alternatives for multiple choice quizzes?

### **Course overall again:**

- Changes for how the course is run?
- Relationship between online modules and the lectures?
- Lecture contents or how they are run?
- Why those changes?

Anything else that you would like to add about this topic?

## 9 Appendix B: Teacher Interview Structure

### Start of the interview:

- Is it okay, that we record the interview? This is only used as research purposes.
- Record names of interviewee, interviewer and date of the interview.
- Background from the research: I am currently working on my master's thesis about use of digital teaching materials in the teaching of project business. In this interview we are interested how you teach currently and how you use digital teaching materials in your teaching.

### Background:

- Could you tell about yourself and your background?
- Which kinds of courses you have been teaching/been part of?

### Teaching:

- Which kinds of courses you teach currently?
- What are the contents of those courses?
- Why these are the chosen contents in courses?
- How course goes from the point of view of the student?
- How course goes from the point of view of the teacher?
- What is the role of contact teaching? What happens during the contact teaching?
- What happens outside of the contact teaching? Which kinds of assignments and materials is used to teach?
- Why this course is structured as it is?
- Which other kinds of teaching methods have you employed in your previous courses?

### Use of digital teaching materials based on course events:

- Could you tell me about a course that has used digital teaching materials?
- When the course was implemented?
- Where did you get the idea to use digital teaching materials?
- What kinds of digital teaching materials was used?
- How production went?
- How it was implemented in teaching?
- Which kinds of experiences did you get from the use of digital teaching materials?
- Why did you want to use digital teaching materials in the course?
- What kinds of feedback did you get?

### Videos:

- Have you used videos otherwise in your teaching?
- What use of videos demand in teaching?
- How have you used self-produced video materials?
- What opportunities do you see in the use of videos in teaching?
- What limits the use of videos in teaching?
- Have you collected data about the use of videos?
  - How have you collected data about use of videos?
- Feedback from students about the use of videos?

### Ending:

- Do you have anything to add? Would you like to discuss about something that relates to use of digital teaching materials?
- Do you know any other people that we should contact about theme of the interview?

## 10 Appendix C: Links to public educational videos used as sources

In this appendix we provide links to educational videos in English which were used as teaching materials for case courses, data sources for the thesis, and are in public distribution.

Youtube channel for Finnish Project Business videos (Projektiliiketoiminta):

<https://www.youtube.com/channel/UCBgL5h2qbRs38fuDLJeLLZQ>

Youtube channel for English Project Business videos:

<https://www.youtube.com/channel/UCWXZegKuVxTTH9Sgij2yuSQ>

Links for individual videos that are in English:

Case Course	Name of the Video	Link
FITech Proj Man 2019	1-1 What is project business	<a href="https://www.youtube.com/watch?v=9IGJ-t3flpQ">https://www.youtube.com/watch?v=9IGJ-t3flpQ</a>
FITech Proj Man 2019	1-2 Projects are about future orientation	<a href="https://www.youtube.com/watch?v=1o5RgDopFbE">https://www.youtube.com/watch?v=1o5RgDopFbE</a>
FITech Proj Man 2019	1-3 One project is many projects – distinguishing between customer's and supplier's perspectives	<a href="https://www.youtube.com/watch?v=ix7M-wsGHao">https://www.youtube.com/watch?v=ix7M-wsGHao</a>
FITech Proj Man 2019	1-4 Operating environment of project business	<a href="https://www.youtube.com/watch?v=xF3jeRdrgyk">https://www.youtube.com/watch?v=xF3jeRdrgyk</a>
FITech Proj Man 2019	1-5 Project objectives and trade offs in managing projects	<a href="https://www.youtube.com/watch?v=9_Pgl_9O0Gw">https://www.youtube.com/watch?v=9_Pgl_9O0Gw</a>
FITech Proj Man 2019	1-6 Project stakeholders	<a href="https://www.youtube.com/watch?v=Q2mG4OnzUAg">https://www.youtube.com/watch?v=Q2mG4OnzUAg</a>
FITech Proj Man 2019	1-7 Project stakeholder management	<a href="https://www.youtube.com/watch?v=ILQe75muP08">https://www.youtube.com/watch?v=ILQe75muP08</a>
FITech Proj Man 2019	1-8 Project management, project stakeholders and lifecycle	<a href="https://www.youtube.com/watch?v=wejp79Wwo6o">https://www.youtube.com/watch?v=wejp79Wwo6o</a>
FITech Proj Man 2019	2-1 Introduction to project marketing and sales_onedrive	<a href="https://www.youtube.com/watch?v=0EpxOmqP0bk">https://www.youtube.com/watch?v=0EpxOmqP0bk</a>
FITech Proj Man 2019	2-2 Tendering	<a href="https://www.youtube.com/watch?v=XUA0wQ5sNes">https://www.youtube.com/watch?v=XUA0wQ5sNes</a>
FITech Proj Man 2019	2-3 Bidding	<a href="https://www.youtube.com/watch?v=hLjZvU0bNBM">https://www.youtube.com/watch?v=hLjZvU0bNBM</a>
FITech Proj Man 2019	2-4 Projektin negotiations and contract management	<a href="https://www.youtube.com/watch?v=6wOk_Qft_Oc">https://www.youtube.com/watch?v=6wOk_Qft_Oc</a>
FITech Proj Man 2019	2-5 Managing sales and marketing	<a href="https://www.youtube.com/watch?v=P7bEOs8fgZE">https://www.youtube.com/watch?v=P7bEOs8fgZE</a>
FITech Proj Man 2019	3-1 Introduction to project planning and control	<a href="https://www.youtube.com/watch?v=qrKgK120r5Q">https://www.youtube.com/watch?v=qrKgK120r5Q</a>
FITech Proj Man 2019	3-2 Integration management	<a href="https://www.youtube.com/watch?v=LRHaz0H8LIM">https://www.youtube.com/watch?v=LRHaz0H8LIM</a>
FITech Proj Man 2019	3-3 Scope management	<a href="https://www.youtube.com/watch?v=lyj2groqlsl">https://www.youtube.com/watch?v=lyj2groqlsl</a>
FITech Proj Man 2019	3-4 Project product and work breakdown	<a href="https://www.youtube.com/watch?v=ucJ8hAIOifl">https://www.youtube.com/watch?v=ucJ8hAIOifl</a>
FITech Proj Man 2019	3-5 Introduction to project schedule and resource management	<a href="https://www.youtube.com/watch?v=EfZKuM9onZ4">https://www.youtube.com/watch?v=EfZKuM9onZ4</a>
FITech Proj Man 2019	3-6 Projects as complex activity networks calculating activity networks	<a href="https://www.youtube.com/watch?v=vYGqY6vYBrc">https://www.youtube.com/watch?v=vYGqY6vYBrc</a>
FITech Proj Man 2019	3-7 Resource planning in projects	<a href="https://www.youtube.com/watch?v=P_lupnrwWOnM">https://www.youtube.com/watch?v=P_lupnrwWOnM</a>
FITech Proj Man 2019	3-8 What is cost management, basic principles of cost related phenomena, and hierarchical structures	<a href="https://www.youtube.com/watch?v=P0iDNtID10Q">https://www.youtube.com/watch?v=P0iDNtID10Q</a>
FITech Proj Man 2019	3-9 Cost estimate as forecast, and budget as target	<a href="https://www.youtube.com/watch?v=9tjKzCRUgqQ">https://www.youtube.com/watch?v=9tjKzCRUgqQ</a>

FITech Proj Man 2019	3-10 Timing principles in cost recording, and cost reporting with illustrative sample reports	<a href="https://www.youtube.com/watch?v=s7L_p_SVMmk">https://www.youtube.com/watch?v=s7L_p_SVMmk</a>
FITech Proj Man 2019	3-11 Three point estimates encoding values, calculating risks, and their project risk management app	<a href="https://www.youtube.com/watch?v=KLZACF-5J-I">https://www.youtube.com/watch?v=KLZACF-5J-I</a>
FITech Proj Man 2019	3-12 Reporting deviations	<a href="https://www.youtube.com/watch?v=lgmyKBDWFi8">https://www.youtube.com/watch?v=lgmyKBDWFi8</a>
FITech Proj Man 2019	4-1 Buying projects as a way to organize, and definition of procurement packages	<a href="https://www.youtube.com/watch?v=uAYa-c8uXZk">https://www.youtube.com/watch?v=uAYa-c8uXZk</a>
FITech Proj Man 2019	4-2 Looking the procurement from risk transfer perspective	<a href="https://www.youtube.com/watch?v=NBEedME8tQgE">https://www.youtube.com/watch?v=NBEedME8tQgE</a>
FITech Proj Man 2019	4-3 Project procurement process and process related considerations	<a href="https://www.youtube.com/watch?v=zWEhh29nNBY">https://www.youtube.com/watch?v=zWEhh29nNBY</a>
FITech Proj Man 2019	4-4 Introduction to risk management	<a href="https://www.youtube.com/watch?v=-s7p3ck0YvU">https://www.youtube.com/watch?v=-s7p3ck0YvU</a>
FITech Proj Man 2019	4-5 Identifying risks	<a href="https://www.youtube.com/watch?v=i8_97fluic">https://www.youtube.com/watch?v=i8_97fluic</a>
FITech Proj Man 2019	4-6 Evaluating risks	<a href="https://www.youtube.com/watch?v=pkwLxGRTWho">https://www.youtube.com/watch?v=pkwLxGRTWho</a>
FITech Proj Man 2019	4-7 Planning and executing risk responses	<a href="https://www.youtube.com/watch?v=kGuv1tEfB9w">https://www.youtube.com/watch?v=kGuv1tEfB9w</a>
FITech Proj Man 2019	4-8 Risk management across the project life cycle	<a href="https://www.youtube.com/watch?v=nLJHWLBN-CU">https://www.youtube.com/watch?v=nLJHWLBN-CU</a>
FITech Proj Man 2019	4-9 Quality management in projects	<a href="https://www.youtube.com/watch?v=McuFceqvMbU">https://www.youtube.com/watch?v=McuFceqvMbU</a>
FITech Proj Man 2019	4-10 Communication and information management in projects	<a href="https://www.youtube.com/watch?v=8fT3zuRoofs">https://www.youtube.com/watch?v=8fT3zuRoofs</a>
FITech Proj Man 2019	5-1 Integration management over the project	<a href="https://www.youtube.com/watch?v=wd5atc80kD8">https://www.youtube.com/watch?v=wd5atc80kD8</a>
FITech Proj Man 2019	5-2 Analyzing project progress and producing estimate at completion – earned value	<a href="https://www.youtube.com/watch?v=K_H5WnTKr5o">https://www.youtube.com/watch?v=K_H5WnTKr5o</a>
FITech Proj Man 2019	5-3 Evaluation of project success	<a href="https://www.youtube.com/watch?v=0y2XamAPQdI">https://www.youtube.com/watch?v=0y2XamAPQdI</a>
FITech Proj Man 2019	6-1 The human resources of a project	<a href="https://www.youtube.com/watch?v=FICMKONbAW4">https://www.youtube.com/watch?v=FICMKONbAW4</a>
FITech Proj Man 2019	6-2 Project organization	<a href="https://www.youtube.com/watch?v=U_9Iia4Rvhk">https://www.youtube.com/watch?v=U_9Iia4Rvhk</a>
FITech Proj Man 2019	6-3 The work of a project team	<a href="https://www.youtube.com/watch?v=KF-LtHeuz4">https://www.youtube.com/watch?v=KF-LtHeuz4</a>
FITech Proj Man 2019	6-4 Leading the project team	<a href="https://www.youtube.com/watch?v=ojaf6Wt_VCA">https://www.youtube.com/watch?v=ojaf6Wt_VCA</a>
FITech Proj Man 2019	6-5 Projects as part of a company's organization structure	<a href="https://www.youtube.com/watch?v=wAqw7jx3oho">https://www.youtube.com/watch?v=wAqw7jx3oho</a>
FITech Proj Man 2019	7-1 Services in project business	<a href="https://www.youtube.com/watch?v=0twteWdUIYU">https://www.youtube.com/watch?v=0twteWdUIYU</a>
FITech Proj Man 2019	8-1 Managing project business	<a href="https://www.youtube.com/watch?v=Vb3A4_DXgbw">https://www.youtube.com/watch?v=Vb3A4_DXgbw</a>
FITech Proj Man 2019	8-2 From cost management of a project to managing profitability at the firm level	<a href="https://www.youtube.com/watch?v=5r8g7n-2wMA">https://www.youtube.com/watch?v=5r8g7n-2wMA</a>
DIEM Proj Bus 2019	Neste 1 Petri Jokinen, Director, Neste	<a href="https://www.youtube.com/watch?v=-nIgf5oGGVE">https://www.youtube.com/watch?v=-nIgf5oGGVE</a>
DIEM Proj Bus 2019	Neste 2 Neste and renewable products the business and projects	<a href="https://www.youtube.com/watch?v=RQS24O3zGMw">https://www.youtube.com/watch?v=RQS24O3zGMw</a>
DIEM Proj Bus 2019	Neste 3 Establishing production in a new location at an international level	<a href="https://www.youtube.com/watch?v=au0MPM6_Zy8">https://www.youtube.com/watch?v=au0MPM6_Zy8</a>
DIEM Proj Bus 2019	Neste 4 NEXBTL plant project timeline	<a href="https://www.youtube.com/watch?v=DWpv5nv-y5g">https://www.youtube.com/watch?v=DWpv5nv-y5g</a>
DIEM Proj Bus 2019	Neste 5 Organization of NEXBTL project	<a href="https://www.youtube.com/watch?v=c2cqG_OUYyw">https://www.youtube.com/watch?v=c2cqG_OUYyw</a>
DIEM Proj Bus 2019	Neste 6 Tools of NEXBTL project	<a href="https://www.youtube.com/watch?v=dblXGzoUaI8">https://www.youtube.com/watch?v=dblXGzoUaI8</a>
DIEM Proj Bus 2019	Neste 7 Procurement of projects in the NEXBTL major project	<a href="https://www.youtube.com/watch?v=4_9mBUnlZSY">https://www.youtube.com/watch?v=4_9mBUnlZSY</a>
DIEM Proj Bus 2019	Neste 8 Managing risks, opportunities, and uncertainties	<a href="https://www.youtube.com/watch?v=9s44h4MwPXg">https://www.youtube.com/watch?v=9s44h4MwPXg</a>