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Improving University Teaching: A Professional Service Operation Perspective

Structured abstract

Purpose – The study takes a professional service operation (PSO) perspective to reconceptualise a persistent pedagogical dilemma of teaching large classes into a process design challenge. This enables developing a solution that both reduces labour intensity and improves the customisation of teaching.

Design/methodology/approach – This work is based on a single-case analysis of an undergraduate operations management course taught at a UK-based global top-50 business school. The research process follows the Design Science approach where a prior course design is analysed and a redesign is presented, refined and tested using data on student satisfaction.

Findings and practical implications – The course redesign is based on the flipped learning pedagogy, and uses a combination of process analysis and educational science perspectives. The redesign seems to provide benefits to students without increasing labour intensity. The developed six-step systematic approach should reduce the labour intensity of university-level teaching operations, while providing additional possibilities for customisable in-class active learning.

Originality/value – This study shows how the resource-constrained value creation of teaching operations can be improved systematically using process analysis perspectives. The work also scrutinises the flipped learning pedagogy from a PSO perspective and shows its benefits for improving teaching operations compared to traditional lecturing.

Research limitations/implications – The empirical findings from the single-case design cannot be directly generalised to other contexts. However, the developed six-step systematic approach for redesigning the university-level teaching process should be applicable to other teaching operations to drive value creation and improve processes.

Paper type – Research paper.

Keywords – Professional service operations, service design, process improvement, teaching and learning, flipped learning.

1 Introduction

How can better economic growth be facilitated and how can education contribute to this process? Why is productivity improvement more difficult to achieve in services compared to manufacturing? Such fundamental questions are more relevant than ever and serve as the inspiration for this paper. Researchers are seeking ways to improve service productivity (e.g., Gronroos and Ojasalo, 2004; Schmenner, 2004) but more solutions are needed. The centrality of human resources and their capabilities in modern economies make education systems critical for long-term economic growth. At the same time, universities feel pressure to improve their operations, while facing significant resource constraints and increasing global competition. Entrants, such as Khan Academy, Coursera and EdX, have radicalised parts of the education sector by using the Internet and communication technologies (ICT) to drive innovation. These actors deliver teaching contents, materials and courses to masses of people around the world with ease of use and low costs that would have been impossible just two decades ago. Yet, while universities are struggling to respond to these developments, most of them only use ICT for communication (Arbaugh *et al.*, 2013; Arenas-Marquez *et al.*, 2012; Greasley *et al.*, 2004) and continue to rely heavily on mass lecturing.

Lecture-based teaching enables universities to increase class sizes and seems to offer possibilities for surviving their current financial realities. However, lecturing has been identified as counterproductive for students' learning due to the lack of interactions and feedback in the classroom (Hattie, 2012; Hattie and Yates, 2013). The drawbacks of lecturing manifest in the persistent pedagogical dilemma of lecturing producing significantly worse learning results than individual tutoring (Bloom, 1984). Educational scientists have long sought to solve this dilemma (e.g., King, 1993; Mazur, 1997); however, despite their attempts and the pressures from new ICT-based education providers, lecturing still dominates university curricula. This paper argues that the perspectives of educational science could be enriched through insights into process analysis, in order to develop teaching operations that could provide better learning, even with tight resource constraints. In particular, many providers of professional service operations (PSOs) struggle in the same ways as universities to provide customised high-value services to larger numbers of clients (Chase, 1978). As an example of efficient mass service, low-cost airlines are able to provide transportation services to millions of people with very low cost structures. Similarly, universities need to provide education much more efficiently, but in a manner that provides good results in terms of students' learning.

This study reconceptualises the pedagogical dilemma of large classes into an operations management (OM) challenge. The idea is to simultaneously improve the value and efficiency of teaching operations through systematic process improvement (see Bitner *et al.*, 2008). This work focuses on studying the systematic ways to apply such a process improvement. Then, the outcome of this process improvement should be a service process design that requires both lower labour intensity as the main factor of cost and improved customisation for increased value (see Schmenner, 1986). For example, while low-cost airlines balance low customisation with low labour intensity, medical doctors justify their high labour intensity with the high level of value provided by the customised service. Accordingly, universities should seek to balance these two axes, which requires a thorough understanding of pedagogies for

alternative teaching designs. Furthermore, process performance is driven by the management of customer contacts (Chase, 1978; Sampson, 2012) because this affects both labour intensity and customisation. Process automation technologies can facilitate the effective management of customer contact (Harvey, 1998) by reducing manual labour and allowing customers to access services online, anytime and anywhere. This paper argues for the need to cross-fertilise PSO and educational science perspectives to develop ways of redesigning university teaching that reduce labour intensity and better customise teaching approaches to individual needs. Accordingly, the work focuses on the process for improving university teaching, through addressing the following research question:

RQ: How to redesign university-level teaching operations to reduce labour intensity and to improve customisation?

The following literature review provides a theoretical background for the work through analysing and synthesising the literature on PSO and flipped learning in order to define the main challenge of university lecturing and identify possible avenues towards a solution (for a summary of these, see Table 1 in Subsection 2.3). Section 3 presents the research methods that build on a single-case design following the Design Science approach where a solution proposal is developed, refined and tested (for the research process, see Subsection 3.1). Section 4 presents a novel six-step approach that represents the process for redesigning teaching operations and the outcome from this process as a course redesign for an undergraduate OM course (see Subsection 4.1 and Appendix A for the course syllabus). Section 4 also presents the findings from the analysis of student feedback on the course redesign (Subsection 4.2). Finally, Section 5 discusses the paper's implications for academia and teaching practices, as well as the limitations and future research avenues.

2 Literature review: university teaching process improvement

This section analyses university teaching from a professional service operation (PSO) perspective in order to study how different teaching approaches affect process design and to explore how university teaching operations could be improved through alternative process designs that are informed by pedagogical perspectives. To achieve this, PSO and educational science literature perspectives are synthesised in Subsection 2.3 and summarised in Table 1.

2.1 University teaching as a professional service operation

This work perceives university teaching as a PSO where value is co-created together with students. Service operations generally process people, their belongings or information (Wemmerlov, 1990; Sampson, 2000), while PSOs mainly process information and people's knowledge. PSOs are considered knowledge-intensive, which refers to value creation that largely results from the knowledge of and decisions made by the service personnel (Von Nordenflycht, 2010; Harvey *et al.*, 2016). For example, discussing complex topics with students requires the instructor to possess professional knowledge of the topics and pedagogies, as well as the capabilities to interact effectively with students. PSOs can be characterised based on four dimensions: routinisation (Wemmerlov, 1990; Lillrank and Liukko, 2004), customer contact (Wemmerlov, 1990; Sampson, 2012), customisation (Silvestro, 1999; Schmenner,

1986, 2004) and the role of technology (Boone and Ganeshan, 2001; Lawrence *et al.*, 2016). This Subsection discusses these dimensions and examines the challenges of traditional lecturing.

The *routinisation* of processes involves reducing task variety (Wemmerlov, 1990). This can be valuable for process improvement because it allows for the use of lower-skilled resources and automation to drive process efficiency (Lewis and Brown, 2012; Lawrence *et al.*, 2016). PSOs consist of a combination of non-routine, routine and possibly standardised processes (Lillrank and Liukko, 2004). Non-routine processes allow for flexibility but require low volumes, while routine and standard processes enable higher volumes but provide less flexibility (Wemmerlov, 1990). Customer-facing processes often require flexibility because they build on the judgement of professional service personnel, which makes them non-routine and difficult to standardise (Brandon-Jones *et al.*, 2016). It is usually assumed that customers prefer more interaction (e.g., Chase, 1978; Harvey, 1998; Harvey *et al.*, 2016), which requires non-routine processes. For example, students are considered to prefer face-to-face delivery rather than independent studies. The challenge is that non-routine processes require flexibility and are much more reliant on the individual instructor's skills, thus making the process less amenable to automation (Wemmerlov, 1990). The central tension in designing university teaching processes is between the required flexibility and the simultaneous need for routinisation (see Lawrence *et al.*, 2016).

Direct *customer contact* distinguishes service operations from manufacturing (Sampson and Froehle, 2006), which poses particular challenges for process control. Chase (1978) characterises general production operations, depending on customer contact, into: pure service, mixed service, quasimanufacturing and manufacturing. PSOs are often considered pure services (e.g., Wemmerlov, 1990; Harvey *et al.*, 2016) because of their knowledge-intensity. However, mass lecturing barely has more interaction than quasimanufacturing, but does not benefit from process automation like a typical quasimanufacturing process does. Accordingly, to be categorised, some PSOs need to be decomposed into their constituent sub-processes. Characterising sub-processes can be done using Wemmerlov's (1990) distinction of customer contact: *direct contact* through physical presence, *indirect contact* through media and *no contact* (see also Sampson, 2012). Direct interactions among students and instructors provide possibilities for feedback from learning, which is identified as essential for learning (Hattie 2008, 2012; Hattie and Yates, 2013). However, analysing sub-processes of teaching operations may reveal the possibility to move simple transactions away from direct contact, which could improve process efficiency by allowing for routinisation and, possibly, automation (Karwan and Markland, 2006; Lawrence *et al.*, 2016). This would provide more possibilities to benefit from scale, time independence and lower-skilled labour, as well as improve the specialisation of the workforce and resources (Chase, 1978; Wemmerlov, 1990). However, despite mass lecturing involving little real interaction, it is still time-dependent, requires highly skilled labour and benefits from specialisation and scale only to a small degree.

Customisation of services is important to serve individual needs. For example, medical doctors should listen to their patients carefully in order to diagnose conditions correctly and treat the patient with courtesy and respect. Schmenner (1986) presents an impactful service process categorisation that is based on the process's labour intensity and the degree of interaction/customisation. He describes university teaching as follows: 'seldom do student consumers actively intervene in the process. Thus

college teaching has a comparatively low level of interaction. [...] College teachers, on the other hand, are reluctant to throw out the syllabus to accommodate student desires: they “teach what they know” (Schmenner, 1986, pp. 22–23). Accordingly, traditional lecturing can be considered a labour-intensive process but relatively low in both interaction and customisation, which often results in high costs and low value. This paper intentionally differentiates between interaction and customisation because they are interdependent but not in a linear manner. Studies have found that most services reach optimal productivity when customisation is at a similar level with labour intensity (e.g., Chase, 1978; Silvestro, 1999; Schmenner, 2004).

Technologies can be used as enablers of alternative PSO process designs, thus improving quality and cost performance simultaneously (Harvey, 1998). A combinatorial approach involves new enabling technologies, such as ICT, together with process redesign to drive customer value and process efficiency (Boone and Ganeshan, 2001; Karwan and Markland, 2006; Lawrence *et al.*, 2016). ICT can be used in PSO operations for two main purposes: to collect and document information, or to be a part of the production process itself (Boone and Ganeshan, 2001). Universities use ICT mainly for course communication and delivering various documents to assist with the logistics related to managing courses (Arbaugh *et al.*, 2013; Arenas-Marquez *et al.*, 2012; Greasley *et al.*, 2004). However, Boone and Ganeshan (2001, pp. 485) found out that only ‘technology which becomes a part of the production process is associated with productivity improvements, while information technology which merely documents or collects information is not’. New education providers, such as Khan Academy and Coursera, use ICT as part of their core teaching delivery process, while universities usually only do this in distance learning (DL) programs, despite mass lectures being *de facto* routinised processes delivered by manual labour. Accordingly, universities are deprived of the productivity gains that existing ICT can provide.

2.2 The pedagogical dilemma of large classes and attempts to find solutions

In university teaching, value is defined by students’ learning (Barr and Tagg, 1995), which is co-created in a process wherein students interact with their peers, the instructor and the course materials. According to Bloom’s (1956) taxonomy, students’ learning takes place along six levels of cognitive skills that increase in sophistication: knowledge, comprehension, application, analysis, synthesis and evaluation. An effective way to achieve excellent learning results is individual one-on-one tutoring (Bloom, 1984), which is characterised by rich instructor-student interaction and active learning. However, universities have responded to cost pressures largely by providing more lecture-based teaching to enable increases in class size (Hornsby and Osman, 2014; Maringe and Sing, 2014), despite the fact that mass lecturing has been identified as counterproductive for students’ learning for a number of reasons. In particular, the instructor lacks time to address students’ individual learning needs and cultural diversity (Maringe and Sing, 2014), which leads to little two-way communication (King, 1993, 1994) and reduced possibilities for questions and discussions (Cuseo, 2007; Maringe and Sing, 2014). In large lectures, students are often unprepared and unmotivated because of reduced accountability and lack opportunities for feedback on their learning (Michaelsen *et al.*, 1982; Carbone and Greenberg, 1998). This creates challenges in developing communication skills, critical thinking and problem solving (Carbone and Greenberg, 1998; Hornsby and Osman, 2014). Together, these issues contribute to mass

lecturing producing, on average, significantly worse learning results than individual tutoring (Bloom, 1984; Cuseo, 2007; Maringe and Sing, 2014). Accordingly, a persistent *pedagogical dilemma* is how to achieve learning results similar to those of individual tutoring when teaching larger classes.

Mazur (1997) made one of the earliest attempts to solve this dilemma with large classes. The idea is to remove unnecessary content delivery from the lectures by providing students with lecture notes (Mazur, 1997), reading tasks (e.g., Berrett, 2015) and/or pre-recorded video 'lecturettes' (Bergmann and Sams, 2012) before the lecture. This strategy was later given several names: 'flipped learning', 'classroom flip', 'inverted classroom' and 'flipped classroom'. This study uses the term 'flipped learning' to reflect a student-centred approach where learning has priority over teaching (for more information on the learning versus teaching paradigm, see Barr and Tagg, 1995). The word 'flipped' has a dual meaning in this context. First, in-class activities are flipped with those that are traditionally completed outside of class (Bishop and Verleger, 2013). Second, Bloom's (1956) taxonomy is flipped upside down in terms of the cognitive skill levels addressed in class versus outside of class. Traditional lecturing generally targets lower-level cognitive skills (Bloom, 1956), such as knowledge and comprehension, through content delivery, while homework traditionally requires students to go beyond those skills into analysis, application and, possibly, into synthesis and evaluation. Flipped learning intentionally targets the higher levels of learning in class where students have access to the instructor who can support them during these challenging learning tasks, while students acquire general knowledge and comprehension at home before coming to class (Bergmann and Sams, 2012; Hibbard *et al.*, 2016).

Flipped learning can be used without modern technologies or by blending online elements (Arbaugh *et al.*, 2013; Asarta and Schmidt, 2017) with in-class instruction (Gilboy *et al.*, 2014; Velegol *et al.*, 2015; Hibbard *et al.*, 2016). Flipped learning was first implemented using online video lecturettes as blended elements at Woodland Park High School in Colorado during the 2007–2008 academic year (see Bergmann and Sams, 2012). Thanks to recent developments in modern ICT, this practice has become popular in subjects, such as chemistry, physics, maths, engineering, medicine and business. For practical execution of flipped learning, it is essential that the approach is explained to the students at the beginning of the course and that it is presented as a potentially beneficial learning strategy. This should allow the majority of students to see the benefits of flipped learning over traditional lecturing (Gilboy *et al.*, 2014); however, a small proportion will likely not be convinced of its efficacy and prefer traditional lecturing (Hibbard *et al.*, 2016). The instructor will also need to be prepared for additional time spent on recording the video lecturettes (Gilboy *et al.*, 2014), which should be considered as an initial investment that yields benefits later on.

Flipped learning is expected to bring several benefits to learning. First, the approach allows more time in the classroom for linking the subject better to practice through site visits and guest lectures (Gilboy *et al.*, 2014; Velegol *et al.*, 2015), which should make learning more interesting (Bergmann and Sams, 2012). Second, flipped learning is expected to improve student engagement in class (Meltzer and Manivannan, 2002; Velegol *et al.*, 2015; Hibbard *et al.*, 2016), which could improve learning results. Better student engagement can be achieved by encouraging dialogue between the instructor and students, using pedagogical methods, such as 'think-pair-share' or 'jigsaw' (King, 1993) and using communication aids, such as flash cards (Meltzer and Manivannan, 2002) or modern ICT (Bergmann and

Sams, 2012). Third, customising teaching to student needs can be improved thanks to reduced time spent on pure content delivery (Mazur, 1997; Bergmann and Sams, 2012). Customisation can mean altering the breadth and depth of a covered topic, providing more support to those in need and allowing more choice in how students interact with the course contents in terms of time, location and possible revision (Bergmann and Sams, 2012; Velegol *et al.*, 2015). This can involve a variety of peer-to-peer and instructor-to-student interactions (Mazur, 1997; Velegol *et al.*, 2015) and increased possibilities for feedback that further improve learning (Hattie, 2008, 2012). Fourth, the introduction of video lecturettes can allow students to acquire theoretical knowledge independently without the need to involve the instructor directly (e.g., Bergmann and Sams, 2012; Berrett, 2015). The video lecturettes also remove pure content delivery from the lectures so that more time can be spent on active learning strategies (King, 1993, 1994; for information on execution, see Bishop and Verleger, 2013). Fifth, flipped learning is often used in conjunction with formative online quizzes that are expected to incentivise learning in a timely manner and throughout the course (Bergmann and Sams, 2012; Velegol *et al.*, 2015), thereby providing a balanced cognitive load for students. This study tested the expected benefits of flipped learning through student feedback, which is reported in Subsection 4.2.

2.3 *Synthesising the PSO and educational science literature for improved teaching operation*

The improvement of teaching processes aims to make learning as effective as possible. Learning is mainly hindered by lecture-based teaching, which only allows 2% of students to achieve the same results as one-on-one tutoring (Bloom, 1984). Translating this persistent pedagogical dilemma into a *process design challenge* can be done by categorising service processes based on labour intensity and customisation (Schmenner, 1986). In particular, individual tutoring enables great amounts of customisation to balance its labour-intensity, while mass lecturing usually offers low interaction despite being relatively labour intensive. Accordingly, a balance should be sought between labour intensity and customisation, which can be achieved through process analysis and searching for answers to Chase's (1978, p. 141–2) questions: 'Can you realign your operations to reduce unnecessary direct customer service? [...] Can you enhance the customer contact you do provide?' Answering the first question would reduce the labour intensity of lecturing, and answering the second question would allow for increased customisation for better value, which could justify high labour costs (see the RQ in Section 1).

The basic process design challenge with university lecturing is similar to that of consumer banking a few decades ago. This challenge was resolved by repositioning activities that were traditionally carried out by manual labour to be delivered by automated teller machines (ATMs) and the Internet (see Chase, 1978; Karwan and Markland, 2006). This process automation (Boone and Ganeshan, 2001; Karwan and Markland, 2006) reduced labour intensity and cost (see Schmenner, 2004), thus creating a quasimanufacturing approach (Chase, 1978). When using process automation for teaching, the ways in which the customer interface is managed become crucial (Chase and Tansik, 1983; Harvey, 1998) and require a clear distinction between (a) strictly controlled automated indirect interactions and (b) enhanced direct interactions in the classroom. In particular, manual routine content delivery can be redirected outside of the classroom (Mazur, 1997) and automated using video lecturettes (Bergmann and Sams, 2012; Bishop and Verleger, 2013) that allows for more time in the classroom to target higher

levels of Bloom's taxonomy. Here, active learning and improved feedback on learning (King, 1993, 1994; Hattie, 2008, 2012) are emphasised in class, which allows for more customisation. This paper refers to this approach as 'technology-enhanced flipped learning' (Bergmann and Sams, 2012). This approach allows for previously idiosyncratic knowledge possessed by the instructor to become embedded in software automation so that the instructor can focus on teaching through direct interaction (Chase, 1978; Lawrence *et al.*, 2016). Table 1 summarises the cross-fertilising PSO and educational science perspectives to solve the main challenge of lecturing, as described above.

Table 1. The main challenge of lecturing and the logic for a possible solution analysed across PSO and educational science perspectives.

	PSO design perspective	Educational science perspective
Main challenge of lecturing	High labour intensity, but low customisation (Schmenner, 1986, 2004)	Large classes produce worse learning than individual tutoring (Bloom, 1984)
Possible solution	Process redesigned based on relocating manual routine activities away from direct contact (Chase, 1978; Karwan and Markland, 2006)	Pure content delivery without interaction removed from in-class (Mazur, 1997)
The solution is based on	(a) Process automation for manual tasks (b) Enhanced customisation for high-contact tasks (Chase, 1978; Lawrence <i>et al.</i> , 2016)	(a) Video lecturettes for pure content delivery (b) More time in-class for targeting higher levels in Bloom's taxonomy (e.g. Bergmann and Sams, 2012; Bishop and Verleger, 2013)
Benefits of automated tasks	Scale, time-independence, lower-skilled labour, and specialisation of workforce and resources (Chase, 1978; Wemmerlov, 1990)	Large classes manageable, video lecturettes viewed at own convenience and do not require skilled labour, but allow specialisation among technical skills, pedagogies and content (e.g. Bergmann and Sams, 2012; Berrett, 2015)
Benefits of enhanced contact	Better customisation (Schmenner, 1986, 2004; Silvestro, 1999)	More active learning & feedback (King, 1993, 1994; Hattie, 2008, 2012)

To improve a process, it is first necessary to identify the particular sub-processes that need to be redesigned and relocated. For this purpose, teaching operations can be mapped using service blueprinting (Shostack, 1984), which focuses on visually depicting processes and identifying points of customer interaction (Shostack, 1984; Bitner *et al.*, 2008; Biege *et al.*, 2012). Sampson's (2012) process chain network (PCN) analysis builds on service blueprinting to improve processes in a visual manner. He suggests that PCN analyses could be used for a number of purposes; however, this study uses it to analyse teaching operations at the level of individual activities. The activities involved in a traditional

lecture can be characterised using Sampson's (2012) PCNs based on the intensity of the interaction. For example, independent processing involves no interaction, while the other actor is physically present in the process steps of direct interaction (see also Wemmerlov, 1990). In surrogate (indirect) interactions, the parties do not meet, but one of them acts on the information, materials and belongings provided by the other (Sampson, 2012). For example, the instructor can prepare teaching technologies independently of the students, but reviewing student feedback requires accessing information that originates from the students. A PCN analysis identifies the most interaction-intensive activities, thus revealing possibilities to relocate these activities to lower levels of interaction.

3 Research methods: the single-case Design Science approach

This study follows the Design Science approach (van Aken, 2004; Holmstrom *et al.*, 2009) to define the problem to be studied and then search for possible solutions. The rationale for using this approach is that developing education cannot be a theoretical-analytical science, such as physics; rather, it has to be based on practical experiments, tests and learning to establish knowledge in a manner that is somewhat similar to medicine. Furthermore, developing teaching methods is about designing artificial systems, which means that it is literally a science of design (see Peffers *et al.*, 2007). In the OM field, Design Science research is entering the mainstream, partly thanks to the Journal of Operations Management recently introducing a new department devoted to studies that use this approach (van Aken *et al.*, 2016). The first empirical results of this department were published recently (Kaipia *et al.*, 2017). Design Science aims to produce knowledge that can be used to implement actions that improve the design of operation systems (van Aken *et al.*, 2016), such as university teaching. Improving university-level teaching operations requires a rich and detailed understanding of the interactions between the phenomena and contexts. Therefore, a single-case design (Yin, 2009) of a university course was deemed the best option available. Furthermore, approaching this practical design challenge requires possibilities to modify teaching operation, test the implications and possibly make additional modifications to the teaching process, which is in line with the Design Science approach (van Aken, 2004; Holmstrom *et al.*, 2009).

3.1 The research process

The research process in this study followed the Design Science research phases described by Holmstrom *et al.* (2009):

0. Starting from a fuzzy or ill-defined problem

Universities currently face tight resource constraints and increasing competition from other universities, as well as from new education providers (see Section 1). This situation was identified to highlight the *pedagogical dilemma* of the prevailing mode of teaching, which is that lecturing large classes does not provide nearly as good learning results as individual tutoring (Bloom, 1984).

1.

a. Constructing and defining the problem

The literatures on PSO and educational science were reviewed (see Section 2), in order to reconceptualise the persistent pedagogical dilemma of large classes into one that could be systematically analysed and possibly solved. Accordingly, lecturing was identified as labour-intensive but not customised, thus creating an imbalance in Schmenner's (1986) service process categorisation. A possible solution (Peffer et al., 2007) aims to balance the labour intensity and customisation of teaching operations by improving the process design. Accordingly, the problem was defined in the form of a research question (presented initially in Section 1):

How to redesign university-level teaching operations to reduce labour intensity and to improve customisation?

b. Developing a solution proposal

This study used a combination of process analysis and educational science perspectives to develop a proposal to solve the problem described above. This involved dividing teaching into two parts: (a) pure content delivery redesigned for minimum labour intensity and (b) in-class activities redesigned for better customisation of learning (see Subsection 2.3 for the logical foundation and Subsection 4.1 for the practical execution). The solution proposal materialized in the form of a full redesign of a lecture-based OM course for Spring 2015, which relied on technology-enhanced flipped learning.

2.

a. Solution refinement

Student feedback and self-reflections from the course in 2015 were used to refine redesign of the course, which included slight amendments to the content, such as emphasising active in-class group learning tasks and adding four additional video lecturettes (see Subsection 4.1). The course redesign was then considered ready for field testing.

b. Field-testing the refined solution

The refined course redesign was implemented for the same undergraduate OM course in the Spring of 2016. A student feedback survey was designed to test the solution by explicitly targeting the potential benefits of flipped learning described in the literature (see Subsections 2.2 for the literature perspective and Subsection 4.2 for empirical testing).

3. Developing substantive theory and/or establishing theoretical relevance

The findings of this study are presented in the paper and used for laying the groundwork in order to form an understanding of the ways in which teaching processes can be systematically improved (see the six-step approach described in Subsection 4.1). The implications of the work are presented in Subsections 5.1 and 5.2 to establish theoretical and managerial relevance, upon which future studies can be built in order to develop teaching operations further.

The research process included a combination of inductive and abductive reasoning (see Mantere and Ketokivi, 2013). Phase 1a involved an iterative process where the literatures on PSO and educational science were reviewed, while searching abductively and iteratively for ways to cross-fertilise those literatures and reconceptualise the problem in order to better allow searching for solutions. Even the research question presented in this paper is the result of refining the original formulation several times as the understanding of the phenomena increased. In Phase 1b, the best candidates for process redesign were sought based on abductive iterations in the literature, empirical data, analysis and conclusions. The process improvement included developing a six-step approach (see Subsection 4.1) that described how the improvement would take place. In Phase 2a, findings from the implementation were collected and used (step six in the six-step approach) to refine the course redesign and to find a better solution to the RQ. This meant going through the six steps of the developed systematic approach anew, resulting in a refined solution that was used in the course in the Spring of 2016. The course syllabus in Appendix A presents the details of the redesigned course, while Subsection 4.1 presents the ways in which the redesign was created. The redesign was then field-tested in the Spring of 2016 by collecting student feedback on the potential benefits of the flipped learning design, the findings from which are presented in Subsection 4.2. The student feedback was analysed using a quantitative analysis of the satisfaction and a qualitative content analysis of student insights on the different elements of the expected benefits (see Subsection 2.2) of flipped learning.

3.2 *Sampling logic*

The researchers selected the case study using purposeful sampling (Yin, 2009). Both the research question and the Design Science approach required researchers to have the possibility to acquire confidential data on student satisfaction and to be able to redesign the course to test the proposed solution. Therefore, the sample focused on a course that was taught by the authors, which was an OM course with business and management undergraduates at a UK-based global top-50 business school. The course was comparable to most introductory OM courses in business schools, at least in the UK. More than 300 students usually take the course, but recently the numbers have gone up to around 400. This large number of students highlights the need to skilfully manage the labour intensity of teaching, which suits the study's objectives perfectly. The nine-week course involved a two-hour weekly lecture and a one-hour seminar with one of several alternative seminar groups.

A survey was distributed to the students using the course virtual learning environment (VLE) to field-test (see Holmstrom *et al.*, 2009) the modified course redesign in Phase 2b. Qualitative and quantitative student feedback was collected on different aspects of the course design in order to construct and understand the effects of customisation from a student perspective. All of the students in the course were targeted for the survey; therefore, the ideal sample was the entire population of the course. There were 379 enrolled students in the course, out of which 375 showed some activity on VLE and 369 took the final exam. We considered the 375 that showed activity on the VLE to be the sample for this study, because a complete lack of activity on VLE made it impossible to contact the student (see Lambert and Harrington, 1990). Therefore, the fully inactive students were excluded from the sample. Responses were secured from 75 individual students, which means that the realised response rate was 20.0%. We tested the possibility of non-response bias using the Kruskal-Wallis H test because the data were ordinal

(1–5 on a Likert scale) and somewhat skewed. For this purpose, the answers from three successive response waves were compared (Armstrong and Overton, 1977; Lambert and Harrington, 1990), which showed no statistical differences between the groups of responses. Accordingly, the test indicates that the non-response bias had no significant effect on the quantitative survey results.

3.3 Data collection and analysis

The student survey yielded both qualitative and quantitative data. The qualitative section required students to answer three types of text-based questions on the VLE. First, the students listed up to three things they enjoyed about the course. Second, they listed up to three things that could be improved. Third, they provided suggestions on how to improve the course. The students had the opportunity to give feedback at their preferred time and location to make sure they were able to provide their honest opinions. All of the student survey data was anonymised to guarantee the full confidentiality of individual students, and the findings are reported here on the level of the entire student cohort.

The study operationalised the key constructs of interest in the following manner. First, labour intensity was defined as the incurred labour costs in relation to the total costs to run the teaching operation (Schmenner, 1986). The total costs of the particular teaching operation were assumed constant during the studied period. This assumption was justified because as the course redesign did not add any resource requirements for delivering the course. This was mostly thanks to the wealth of high-quality resources available at the focal school to support technology-enhanced learning, which might not be the case elsewhere. For the labour costs, the authors followed their own resource utilisation, which remained at the same level as the previous year, except for the additional time spent on recording the video lecturettes. However, the recording was a one-time investment that required a similar amount of work as one year of lecturing the course and could be reused in the coming years. Moreover, practically no teaching resources are used when students view the video lecturettes, meaning a very low labour intensity. Accordingly, the implications of the video lecturettes to reduce labour intensity are relatively straightforward, which is the reason for the empirical part of the study to focus on measuring the effects of the course redesign on customisation.

Second, customisation was defined as the ability of the teaching operation to satisfy the particular preferences of an individual student (Schmenner, 1986), for example, by supporting different learning strategies. This was operationalised as the possible benefits that the flipped learning-based course redesign might provide. These benefits were based on reviewing the flipped learning literature (see Subsection 2.2) and formulated as six statements: 1) The flipped classroom design made the subject more interesting and relevant hence improved the module in general (Bergmann and Sams, 2012). 2) The flipped learning resulted in active student engagement as opposed to passive observation (see Meltzer and Manivannan, 2002; Velegol et al., 2015; Hibbard et al., 2016). 3) The flipped design enabled better customization of learning (Mazur, 1997; Bergmann and Sams, 2012). 4) The video lecturettes were very useful for acquiring the theoretical knowledge (Bergmann and Sams, 2012; Berrett, 2015). 5) Online tests were very useful for incentivizing learning throughout the module (i.e., the course) (Bergmann and Sams, 2012; Velegol et al., 2015). 6) Practitioner lectures were very useful for relating the topics with actual practice (Gilboy et al., 2014; Velegol et al., 2015). Finally, overall student

satisfaction was tested for agreement with the statement: 'On the whole this was a very good module'. All of these seven statements were measured using a five-point Likert scale.

The qualitative data from the survey were drawn to a repository (Yin, 2009) and analysed using NVivo 11 software. The conceptual categories were first identified in an open manner to bring together the data on student insights and key initial ideas (Corbin and Strauss, 1990). Then, the relationships were identified among categories that emerged from the open coding process. Finally, higher order categories (see Corbin and Strauss, 1990) were matched with the potential benefits of flipped learning, which correspond to the headings in Subsections 4.2.1–4.2.5.

4 Findings

Subsection 4.1 describes the way in which the course was redesigned, which is summarised in a developed systematic six-step approach for redesigning teaching operations. This represents the process perspective on redesigning teaching. As an outcome of the improvement process, the refined course redesign for Spring 2016 is presented with details in the course syllabus in Appendix A. Following the Design Science approach, the course redesign and its implications were tested by collecting student feedback. Subsection 4.2 presents the findings on student feedback, which are divided based on the possible benefits of flipped learning.

4.1 The solution: six-step approach to course redesign based on technology-enhanced flipped learning

The teaching operation that previously relied on lecturing was systematically scrutinised and redesigned to develop a solution proposal (Phase 1b of the research process in Subsection 3.1). The main idea behind improving the process was to divide the teaching operation into two parts that were redesigned with separate strategies. First, labour intensity is reduced by automating manual routine tasks and introducing video lecturettes, which were expected to drive cost efficiency. Second, customisation was aimed to be improved for the remaining in-class activities by spending more time on active learning and feedback. These changes should bring the teaching operation closer to the productive diagonal of the service process matrix (Schmenner, 1986), as conceptually illustrated in Figure 1.

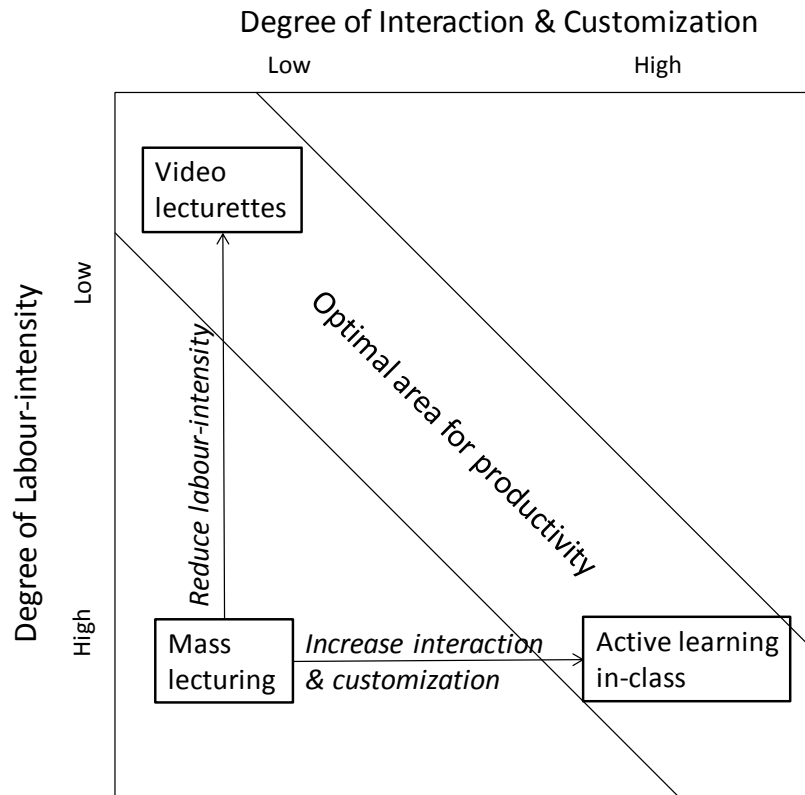


Figure 1. Transferring teaching operations into the productive diagonal of the labour-intensity-customisation matrix (see Schmenner, 1986).

The dual aim of reducing labour intensity and improving the customisation of teaching was pursued according to the following six steps that were based on utilising the insight yielded from the literature review. First, the old teaching process was mapped in order to identify individual activities and the customer contact involved with each activity. Customer contact is crucial because it is linked with labour intensity: direct contact requires manual labour by definition. The process was mapped using Sampson's (2012) PCN diagram (see the left-hand side of Figure 2), because it allowed a focus on different kinds of customer contact. Second, the identified activities were analysed to identify possible candidates of manual routine tasks (highlighted in red on the left-hand side of Figure 2) to be reassigned to less customer contact in order to reduce labour intensity. Lecturing was identified as involving large amounts of routine content delivery without real direct interaction, which mostly refers to the instructor explaining frameworks and their applications while students listen and take notes.

Third, the activities that were identified as involving pure content delivery were reassigned to surrogate interactions with less labour intensity (activities highlighted in red on the right-hand side of Figure 2). In practice, this meant replacing pure content dissemination in class with pre-recorded video lecturettes containing the same contents. This allowed students to view the lecturettes at their preferred times and locations outside of class hours, which could be seen as increased customisation. Labour intensity was reduced because the students could now engage with the contents without direct interaction with an instructor, which even allowed for repeated interactions with the materials. Preparing the video

lecturettes involved similar amounts of work from the instructors compared to conducting in-person lectures on a single course. The recording of videos was considered an investment that would yield benefits in the future. Indeed, the same video lecturettes from 2015 were used in 2016 and supplemented with four additional lecturettes (solution refinement: Phase 2a). The 28 video lecturettes will continue to be available in coming years with the possibility to use them in other courses where applicable. This removes resource usage from pure knowledge dissemination and enables the instructor to focus on innovation for higher-value activities during in-person interactions. Creating video lecturettes may require investment into technologies and/or support personnel in case the university is not as prepared as the university in question.

Fourth, the high-contact teaching in the classroom was redesigned for better customisation by focusing on active learning, emphasising the analysis of case studies and applying the knowledge from the video lecturettes to practical contexts. This allowed more time for student questions and small group discussions, as well as more possibilities for students to receive feedback on their learning. Peer instruction (Mazur, 1997) and activities, such as 'think-pair-share' (King, 1993), were used often because they have been proven effective at achieving active learning, even with larger classes. Incentivising students to view the lecturettes before class was considered crucial because the in-class activities were designed to build on the contents of the video lecturettes. Therefore, online multiple-choice tests were introduced at the beginning of every other lecture and represented 20% of the course assessments. Fifth, the redesigned course was implemented with the entire theoretical contents of the course captured in pre-recorded video lecturettes that were provided through the course VLE. To facilitate the timely progress of all students through contents, the lecturettes were released to students in biweekly phases, with contents related to the subsequent online test. To evaluate the redesign and improve the course in the future, student feedback was collected at the end of the course. Sixth, the course was refined for Spring 2016 based on the information from student feedback by repeating steps 1–5 (see below). Figure 2 below presents a process map of the resulting course redesign. The six-step approach detailed above can be summarised as follows:

- Step 1: Map the teaching process as individual activities from the perspective of customer interaction, using a PCN diagram (see Sampson, 2012).
- Step 2: Study individual teaching activities that involve direct interaction to identify manual routine tasks with unnecessarily high labour intensity (see Chase, 1978; Mazur, 1997).
- Step 3: Explore possibilities to reassign manual routine tasks to involve less customer contact using ICT or other technologies for automating activities (see Boone and Ganeshan, 2001; Karwan and Markland, 2006; Bergmann and Sams, 2012) and invest in automation technology and support resources, if needed.
- Step 4: Design ways to use the newly released direct contact time between instructor and students for more effective teaching approaches, such as active learning (King, 1993, 1994) and enhanced feedback (Hattie 2008, 2012). Introduce online tests to incentivise students to view contents in a timely manner.
- Step 5: Run the redesigned teaching operation in a phased manner for timely learning and collect student feedback to evaluate success.
- Step 6: Improve the teaching operation based on the collected student feedback and return to Step 1.

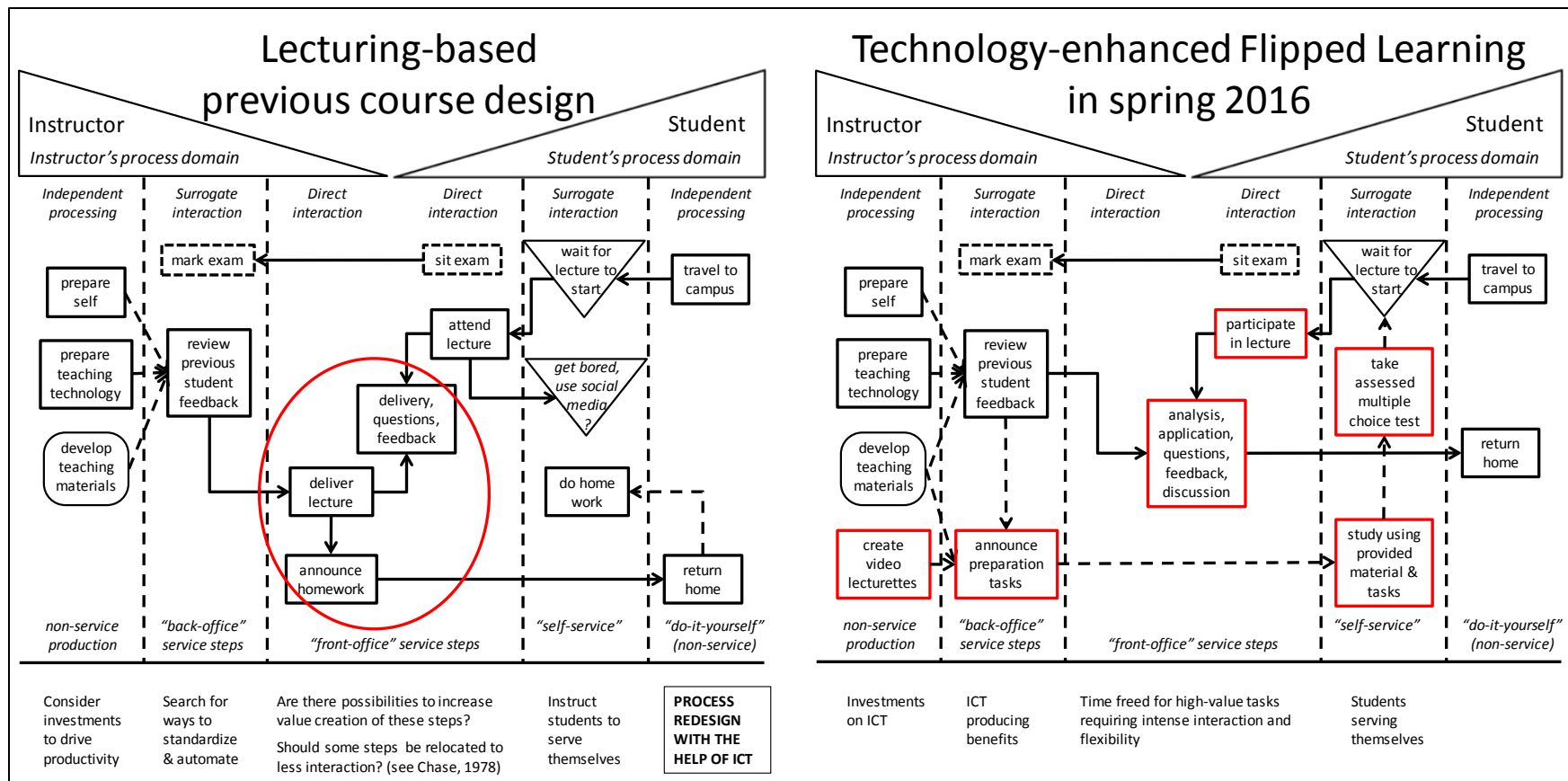


Figure 2. Redesigning the teaching operation of the OM course for 2016 (for PCNs see Sampson, 2012).

The resulting process redesign involved six new or amended activities that are highlighted in red on the right-hand side of Figure 2 (see Appendix A for the module outline in 2016): a) create pre-recorded video lecturettes to replace pure content delivery; b) announce weekly preparation tasks for students on the VLE; c) students study prior to the lecture using the video lecturettes and preparation tasks; (d) introduce bi-weekly multiple-choice tests to incentivise timely and course-long learning; e) students actively participate in lecture discussions and activities and receive feedback on learning from peers, tests, instructors and self-reflection; f) enhance direct interactions among instructors and students to include solving case studies, discuss course content, work in small groups, give and receive feedback and build on student questions.

4.2 Testing the solution: student feedback on the course redesign

Feedback was collected directly from students in order to understand the implications of the redesign on learning. Overall, the students were happy with the redesigned course, despite them being unfamiliar with the approach in the beginning. Comments were received such as, *'i like the teaching method - flipped lectures - the lecture videos are very clear and not redundant - the weekly quiz really motivated us to work hard on revision'*. The average score for the overall student satisfaction on the course in 2016 was 4.33 on a five-point Likert scale, which can be considered excellent and even unusually good for a course with such a high number of students. It is worth noting that the overall student feedback was 4.07 in 2015 when flipped learning was first applied as a solution (Phase 1b of the research process, see Subsection 3.1). This is comparable to the previous year, which used traditional lecturing (overall feedback was 4.04 in 2014 and 4.10 in 2013). This is significant because the lecture-based design had been applied and perfected for years, whereas the flipped learning design was expected to develop and improve based on an increasing understanding of its merits and possible pitfalls. For a comparison with other courses in the well renowned undergraduate programme that this course was part of, the overall average feedback across courses in the programme was 3.99 in the year 2016. Figure 3 summarises the key quantitative results of the student survey in 2016 regarding overall satisfaction with the course and the potential benefits of the course redesign based on flipped learning. The key findings from the student feedback are presented in the following subsections, which represent the five main expected benefits of the course redesign.

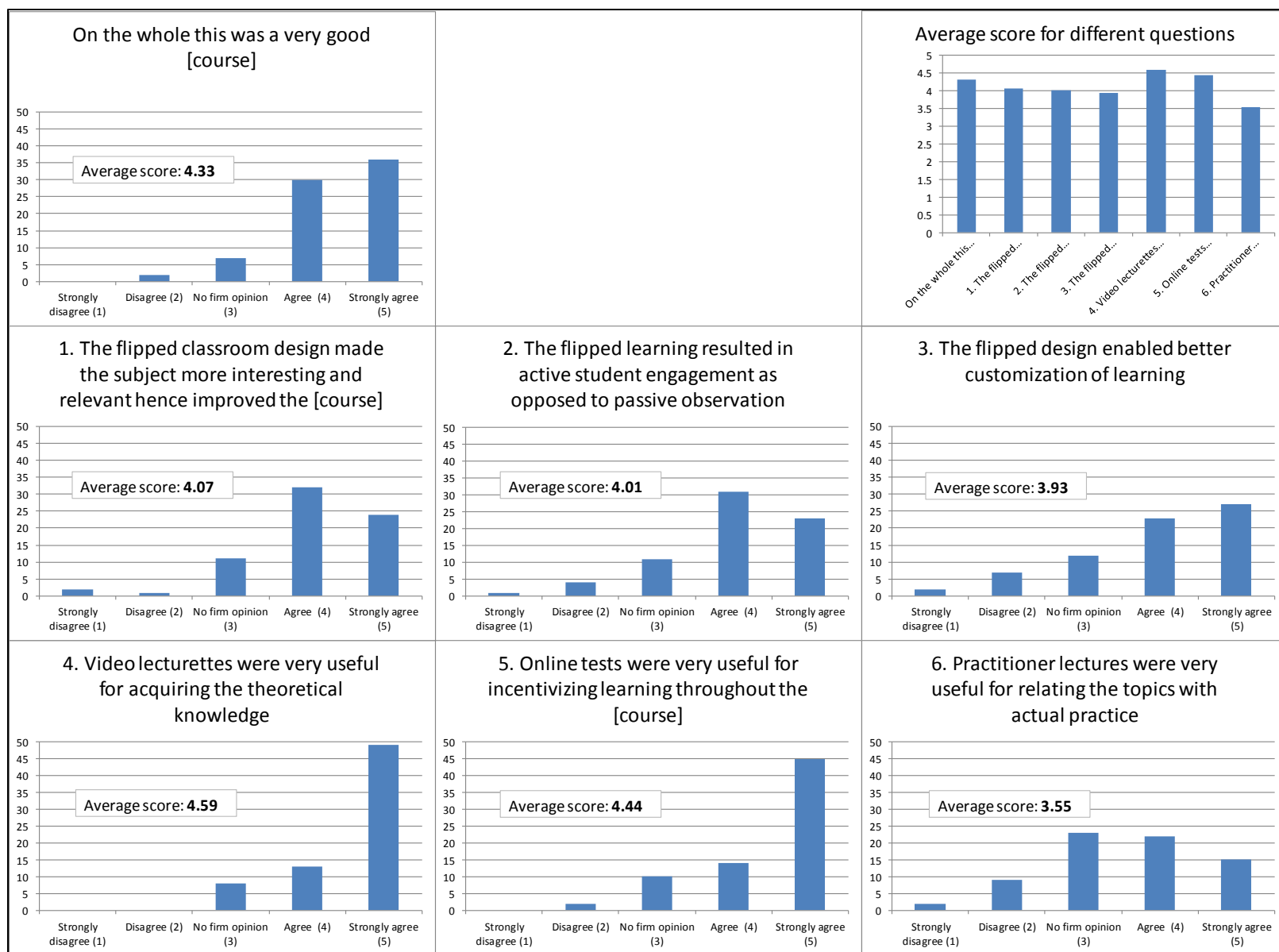


Figure 3. Student feedback on the redesigned course regarding possible benefits of flipped learning.

4.2.1 More interesting subject and topics that are better linked to practice

Students said the new course design benefited learning by making the topic of OM more relevant and interesting and gave it an average score of 4.07 (see Figure 3). The key factor was spending in-class time on interactive activities rather than simply transmitting content. These benefits were highlighted in the following student comment: '1. The approach of "learning by doing": 2. The engaging nature of the lectures and some presentations of the guest lecturers. 3. The very high responsiveness of [the lecturers], both in terms of enquiries and feedback'.

The ways in which OM theories relate to practice are crucial learning points because OM is very much an applied field. Therefore, four one-hour guest lectures by practitioners were included in the course. Some benefits of this approach were identified: 'I would say the guest speakers were the most interesting since it was a good way to see the application of the models in real life. I definitely think this helped my understanding of the content'. However, a few students were dissatisfied with the guest lectures, which revealed contradictory expectations. For example, some students preferred real-life practices, while others wanted to focus on course frameworks: '[I] felt that some of the guest lecturers could use the frameworks we learnt more explicitly in their presentations - some did use the [4Vs] and other frameworks'. 'Guest lectures are useful in general, but I believe they be significantly better if speakers are less tied to the theory'. The guest lectures received the lowest average score (3.55) out of all the areas surveyed, which is still satisfactory.

4.2.2 Active student engagement

One of the main benefits of the course redesign was enabling more active student engagement, which is usually difficult to achieve with such a high number of students in the class (375 active students in 2016). The students indeed saw the redesign as successful because it allowed them to be engaged rather than passive in their learning: 'The approach of [the lecturer] is very engaging and fun. Unlike most courses, I did not feel like a passive learner. The topics are interesting and very applicable in real-life, I have found myself using techniques learned from this course in my daily life and [hobbies]'. Seventy-one out of 75 students confirmed they were 'actively encouraged to contribute' during contact with the instructor. However, not every student felt comfortable with the new teaching approach: 'The lectures tended to be a little pointless as all the course content was in the videos and not really addressed in the lectures'. Despite this, the clear majority saw how the course elements complemented each other and benefited the whole: 'Really enjoyed how the lectures were interactive. Having guest speakers allowed me to understand the course content better and allowed me to remember them with [real] examples'. 'Block tests allowing easy visualisation of understanding interactive seminars, e.g., paper airplane one'. 'The online videos are easy to understand. The seminars are usually very engaging and fun'. Improving active student engagement received an average score of 4.01.

4.2.3 Improved customisation of learning

One of the benefits of using video lecturettes is the possibility to interact with the course contents in a personalised manner. In particular, this refers to the possibility to pause the videos to reflect and take notes, to go back to difficult parts and watch the video again. Several students took advantage of this option that would be helpful especially for exam revision. This can be a major advantage, compared to traditional lecturing where interaction can only take place at the time of delivery. Importantly, the

benefits of video lecturettes are realised over several years; therefore, creating video lecturettes can be considered an investment that will yield benefits at extremely low marginal costs. Indeed, the video lecturettes were viewed several times: the students in the 2016 course viewed each video an average of 4–5 times.

The students' comments on the customisation included: 'the video lectures are really short but insightful they covered the basic knowledge about [OM] saves time in the actual lectures when we can put those theories in practice'. However, customising learning was sometimes considered difficult: 'The structure is not very easy to take in with guest lectures and uneven numbering of the lectures in the blocks. If this structure could be made a bit more clear and logical I think it would improve an already good [course]'. However, most students found the different teaching resources beneficial: 'the availability of resources on [the VLE], the way the slides for the lecture were presented, the block videos were really useful'. On average, the customisation of learning through the course redesign was rated at 3.93.

4.2.4 Video lecturettes enabling acquisition of theoretical knowledge

The video lecturettes were designed to deliver content that included theoretical frameworks, such as the '4Vs' model and polar diagrams. These were then applied using case studies and practical exercises. Moreover, numerous small, in-class learning tasks were used, often in pairs and then later discussed with the whole class, also referred to as 'think-pair-share'. It is worth noting that more advanced cognitive skills, such as analysis, synthesis and self-reflection, were targeted in class, while the videos focused on the lower levels (see Bloom's, 1956 taxonomy). Most students mentioned the videos as one of the best three things of the course: '[1.] Online videos [2.] Online tests [3.] Guest lectures'. '[1.] Summary of the topic videos [2.] Testing knowledge [3.] The content and theory was interesting'. '1. Video lecturettes 2. Speakers from outside 3. Practical seminars (paper airplanes, ...)'. 'the lecture videos are very clear and not redundant - the weekly quiz really motivated us to work hard on revision'. In general, the videos were appreciated and received the highest average score from students at 4.59.

4.2.5 Multiple choice tests that incentivise learning throughout the course

Solutions were sought to motivate students' learning before lectures and throughout the course. The lack of course-long learning was a problem that was identified during the previous course design. The before lecture learning is a concern in the flipped learning pedagogy because in-class teaching relies on students acquiring contents independently before class. The main solution that was used to incentivise students for before class and course-long learning was bi-weekly assessed multiple-choice tests that made up 20% of the final course mark. Fortunately, the students liked the tests and the majority saw why they were necessary. 'The online tests, this way we were encouraged to remember the key learning points'. 'The extra video lecturettes The lecturers were very engaging The tests throughout the term were a good way of testing our knowledge throughout the term'. 'I liked the tests throughout the [course] so that I was motivated to revise throughout. The lecturers were engaging. The block videos were really helpful'.

The tests also provided formal and tangible feedback for the students, which has been previously identified as one of the greatest positive impacts on learning (e.g. Hattie, 2012). Thanks to the redesign, informal feedback was delivered on a number of occasions by the instructors, peers and through self-reflection. Still, it was important that the students acquired explicit feedback on areas that

needed more work: '[...] I also liked the tests because that meant that you would start early on learning and seeing which topics you could do and which you could not'. The online tests received the second highest average score at 4.44.

5 Discussion

This study built on perspectives from two separate fields of literature—professional service operations (PSO) and educational science—in order to study possibilities to improve university teaching. The persistent pedagogical dilemma of delivering learning effectively in large classes was translated to a process design challenge. A combination of process design thinking and educational science perspectives allowed the researchers to design a solution that could address the challenge. A six-step approach was developed for improving a teaching operation systematically. The following subsections discuss the study's implications for theory and practice, as well as its limitations and avenues for future research.

5.1 *Theoretical implications*

Improving university teaching is a crucial task in the changing competitive environment, where the OM community possesses critical skills to provide solutions that go beyond the quality-cost trade off. The theoretical implications of the study are three-fold:

First, the paper extends King's (1993) and Mazur's (1997) work on developing teaching approaches that improve learning results. Particularly, a persistent pedagogical dilemma of teaching large classes was tackled and a solution provided that might be applied to similar problems. To build foundations for solving the problem, the paper brought PSO and educational science literatures together, explicitly linking some of the key pieces from both fields (see Table 1 in Subsection 2.3). The developed solution—the six-step systematic approach (see Subsection 4.1)—can serve as a guideline for improving university teaching, particularly regarding large classes. Further, the work adds to Hattie's (e.g. 2008, 2012) studies on the relative cost efficiency of different teaching strategies through guiding the redesign of a teaching operation in a manner that reduces direct labour costs and improves value. The developed six-step approach can enhance the learning provided by teaching operations in the current harsh financial realities of the educational sector. In particular, building on Mazur's (1997) idea to relocate pure content delivery outside the classroom, this paper showed how ICT could be used to automate parts of the delivery process in teaching. Furthermore, the findings of this study enable better understanding of the process implications for pedagogical choices made when designing university courses.

Second, this work informs the field of PSO through showing a possible solution to the central tension between the simultaneous needs for flexibility and routinisation (Wemmerlov, 1990; Lawrence et al., 2016). In particular, the study identified that the inferior learning results of mass lecturing (e.g. Bloom, 1984; Cuseo, 2007) mean that the operation is located off the productive diagonal of Schmenner's (1986) service process matrix. Further, the work showed how such a mismatch can be solved through process improvement that combines an in-depth understanding of the education context, process improvement thinking and tools (Schmenner, 1986, Sampson, 2012) and the use of modern ICT as process automation technology (Chase, 1978; Karwan and Markland, 2006). Through combinatorial process improvement, this study achieved the seemingly contradictory aim of reducing labour intensity

while increasing customisation (Schmenner, 1986) by drawing a conceptual distinction between two subtypes of teaching as a PSO: (a) automated online elements outside the classroom and (b) face-to-face customizable active learning in the classroom. The former focuses heavily on routinisation and automation to reduce labour-intensity, while the latter should improve value through increased possibilities for customisation. This distinction can contribute to both PSO and teaching development by laying the groundwork for alternative designs of PSOs which simultaneously drive efficiency and flexibility.

Third, this study provides new insights into discussions on the possible benefits of flipped learning (Bergmann and Sams, 2012) compared to lecturing. The strongest support was found on video lecturettes enabling the acquisition of theoretical knowledge, while biweekly tests incentivise learning throughout the course to balance students' cognitive load. This indicates that the combination of ICT-enabled video lecturettes and assessed online quizzes can be beneficial for learning (see Bergmann and Sams, 2012; Bishop and Verleger, 2013). The feedback also supported the notion of flipped learning making the subject more interesting and relevant, improving active student engagement and customising learning. It is slightly surprising that the students did not regard the customisation of learning very highly as the literature identified it as one of the main benefits of the flipped learning pedagogy (King, 1993; Mazur, 1997; Bergmann and Sams, 2012). This might be due to some details that are specific to the course, such as the execution of flipped learning, which shows that there is room for further improvements. Finally, even though flipped learning should allow more time to be spent on practical perspectives (Gilboy *et al.*, 2014; Velegol *et al.*, 2015), the findings did not show much evidence that practitioner lectures are useful for connecting topics with practice. These findings will be considered closely when further improving the teaching operations of the course using the developed six-step approach in coming years.

5.2 Managerial implications

The managerial implications of the work are directed primarily to university teaching staff followed by university management. Lecturers, teachers and professors can benefit from these findings to improve their teaching operations. They can follow the developed six-step approach to systematically analyse their courses in terms of value provision, and seek ways to improve their teaching operations. This can be done without additional resource requirements and even make teaching more enjoyable because there will be more possibilities in class for real interaction instead of routinised content delivery. In addition, teaching staff can use the six-step approach to transition from lecture-based teaching to technology-enhanced flipped learning. Testing the course redesign in an undergraduate OM course showed that students were satisfied with the redesign, which should comfort those who are worried about the possible negative effects of flipped learning on student satisfaction. Redesigning courses according to the six-step approach is not restricted to campus-based teaching but can be extended to blended and DL as well. The live sessions in DL programmes often consist of mere content delivery, which simply replicates ineffective lecture-based teaching. Accordingly, the application of ICT and transferring contents online are not the final solution; rather, it is essential that courses are designed based on the most recent pedagogical research.

University management can use the suggested conceptual distinction of automated online and face-to-face teaching modules when considering the teaching portfolio of their university or school. Accordingly, pure content delivery can be automated independently of the programme and whether

teaching is campus-based, blended or purely online. Faculty members are encouraged to learn from best practices and identify possibilities to use some of the content delivery modules across programmes. This should encourage programme- and school-wide improvement that leads to teaching that is more effective and uses fewer resources. Then, contact time—online or face-to-face—can be devoted to pedagogies that embrace active learning and effective feedback. At the same time, it would be essential for managers at universities to start changing their structures and processes to support the learning paradigm (see Barr and Tagg, 1995). This is likely to require fully redesigning the ways in which teaching is structured, measured, incentivised and rewarded. Universities should reward teaching staff based on student learning and allow teaching professionals to design delivery methods based on what best facilitates learning instead of having to follow the lecture-based structure.

It is hoped that this research will help to solve the contradiction among instructors and university management where the former ask for more resources and the latter design ways to reduce resource usage. In addition, this research should help universities move away from mass lectures. Particularly, technology-enhanced flipped learning can provide improved learning results without creating a need for additional teaching resources. This may require new investments into ICT and support resources, but the benefits will be reaped in the years to come.

5.3 Limitations and future research avenues

The limitations of this research must be considered alongside its merits. The study was based on a single-case design using the Design Science approach, which limits generalizability. The developed six-step approach might be applicable to other knowledge-intensive PSO contexts, but the findings on student satisfaction cannot be generalised directly to other courses. In addition, it is possible that at least some of the positive student feedback might be due to students preferring new approaches just for the sake of novelty or may adjust their behaviour based on awareness of being observed. However, the students had the freedom to answer the feedback survey online at their own convenience. Moreover, the survey was fully in line with the feedback collection process applied across different courses, which makes the Hawthorne effect less likely (see Landsberger, 1958). Since this was an initial exploratory study that used a PSO perspective, further studies are encouraged to explore the effects of the flipped course designs on the process performance of university teaching. We plan to extend this work, by testing the applicability of the analysis approach to other courses and PSO contexts outside of teaching, such as management consulting.

This paper's approach focused on reducing labour intensity and increasing customisation. This has certain limitations in terms of the financial investments required, thus leading to increasing capital intensity. In particular, developing the VLE, creating video lecturettes and writing online quizzes require investments into technology and support resources. The authors are lucky to work for a business school that is committed to investing in such resources, which is the reason why the course redesign presented in this paper did not require additional investment. However, less fortunate universities may need to make additional investments to apply the technology-enhanced flipped designs, thereby decreasing productivity gains. Accordingly, future research could examine more broadly the various indirect costs of teaching and the implications of different teaching approaches on such costs. An interesting question is whether technological development may make university teaching more capital intensive in the future.

The authors consulted the focal school's eLearning team to develop the VLE further in order to retrieve more detailed data on the students' interactions with the course materials, which should make it possible to assess whether there is a causal relationship between viewing the lecturettes and student performance. This data was collected during the Spring 2017 course, followed by further analysis. Accordingly, the research and development efforts form a continuous systematic effort to simultaneously enhance course design and the theoretical understanding of the implications on process performance.

References

- Aken, J.E. van. (2004). "Management Research Based on the Paradigm of the Design Sciences: The Quest for Field-Tested and Grounded Technological Rules", *Journal of Management Studies*, Vol. 41 No. 2, pp. 219–246.
- Aken, J.E. van, Chandrasekaran, A. and Halman, J. (2016). "Conducting and publishing design science research: Inaugural essay of the design science department of the Journal of Operations Management", *Journal of Operations Management*, Vol. 47, pp. 1–8.
- Arbaugh, J.B., DeArmond, S. and Rau, B.L. (2013). "New uses for existing tools? A call to study on-line management instruction and instructors", *Academy of Management Learning & Education*, Vol. 12 No. 4, pp. 635–655.
- Arenas-Márquez, F.J., Machuca, J.A.D. and Medina-López, C. (2012). "Interactive learning in operations management higher education: Software design and experimental evaluation", *International Journal of Operations & Production Management*, Vol. 32 No. 12, pp. 1395–1426.
- Armstrong, J.S. and Overton, T.S. (1977). "Estimating nonresponse bias in mail surveys", *Journal of Marketing Research*, Vol. 14 No. 3, pp. 396–402.
- Asarta, C.J. and Schmidt, J.R. (2017). "Comparing student performance in blended and traditional courses: Does prior academic achievement matter?", *The Internet and Higher Education*, Vol. 32, pp. 29–38.
- Barr, R.B. and Tagg, J. (1995). "From teaching to learning—A new paradigm for undergraduate education", *Change: The magazine of higher learning*, Vol. 27 No. 6, pp. 12–26.
- Bergmann, J. and Sams, A. (2012). *"Flip your classroom: Reach every student in every class every day"*, International Society for Technology in Education, Washington, DC.
- Berrett, D. (2015). "How 'flipping' the classroom can improve the traditional lecture", *The chronicle of higher education*, Vol. 12, pp. 1–14.
- Biege, S., Lay, G. and Buschak, D. (2012). "Mapping service processes in manufacturing companies: Industrial service blueprinting", *International Journal of Operations & Production Management*, Vol. 32 No. 8, pp. 932–957.
- Bishop, J.L. and Verleger, M.A. (2013). "The flipped classroom: A survey of the research", In ASEE National Conference Proceedings, Atlanta, GA.

- Bitner, M.J., Ostrom, A.L. and Morgan, F.N. (2008). "Service blueprinting: a practical technique for service innovation", *California management review*, Vol. 50 No. 3, pp. 66–94.
- Bloom, B.S. (1956). *Taxonomy of educational objectives*. Vol. 1: Cognitive domain. New York: McKay.
- Bloom, B.S. (1984). "The 2 sigma problem: The search for methods of group instruction as effective as one-to-one tutoring", *Educational researcher*, Vol. 13 No. 6, pp. 4–16.
- Boone, T. and Ganeshan, R. (2001). "The effect of information technology on learning in professional service organizations"., *Journal of Operations Management*, Vol. 19 No. 4, pp. 485–495.
- Brandon-Jones, A., Lewis, M., Verma, R. and Walsman, M.C. (2016). "Examining the characteristics and managerial challenges of professional services: An empirical study of management consultancy in the travel, tourism, and hospitality sector", *Journal of Operations Management*, Vol. 42, pp. 9–24.
- Carbone, E. and Greenberg, J. (1998). "Teaching large classes: Unpacking the problem and responding creatively". *To Improve the Academy*, Vol. 17, pp. 311–326.
- Chase, R.B. (1978). "Where does the customer fit in a service operation?", *Harvard Business Review*, Vol. 56 No. 6, pp. 137–142.
- Chase, R.B. and Tansik, D.A. (1983). "The customer contact model for organization design", *Management Science*, Vol. 29 No. 9, pp. 1037–1050.
- Corbin, J.M. and Strauss, A. (1990). "Grounded theory research: Procedures, canons, and evaluative criteria", *Qualitative sociology*, Vol. 13 No. 1, pp. 3–21.
- Cuseo, J. (2007). "The empirical case against large class size: Adverse effects on the teaching, learning, and retention of first-year students". *The Journal of Faculty Development*, Vol. 21 No. 1, pp. 5–21.
- Gilboy, M.B., Heinerichs, S. and Pazzaglia, G. (2015). "Enhancing student engagement using the flipped classroom", *Journal of nutrition education and behavior*, Vol. 47 No. 1, pp. 109–114.
- Greasley, A., Bennett, D. and Greasley, K. (2004). "A virtual learning environment for operations management: Assessing the student's perspective", *International Journal of Operations & Production Management*, Vol. 24 No. 9/10, pp. 974–993.
- Gronroos, C. and Ojasalo K. (2004). "Service Productivity towards a Conceptualization of the Transformation of Inputs into Economic Results in Services", *Journal of Business Research*, Vol. 57, pp. 414–23.
- Harvey, J. (1998). "Service quality: a tutorial", *Journal of Operations Management*, Vol. 16 No. 5, pp. 583–597.
- Harvey, J., Heineke, J. and Lewis, M. (2016). "Editorial for Journal of Operations Management special issue on Professional Service Operations Management (PSOM)", *Journal of Operations Management*, Vol. 42, pp. 4–8.
- Hattie, J. (2008). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. Routledge, New York, NY.

- Hattie, J. (2012). *Visible learning for teachers: Maximizing impact on learning*. Routledge, New York, NY.
- Hattie, J. and Yates, G.C., (2013). *Visible learning and the science of how we learn*. Routledge, New York, NY.
- Hibbard, L., Sung, S. and Wells, B. (2015). "Examining the effectiveness of a semi-self-paced flipped learning format in a college general chemistry sequence", *Journal of Chemical Education*, Vol. 93 No. 1, pp. 24–30.
- Holmström, J., Ketokivi, M. and Hameri, A. (2009). "Bridging Practice and Theory: A Design Science Approach", *Decision Sciences*, Vol. 40 No. 1, pp. 65–87.
- Hornsby, D.J. and Osman, R. (2014). "Massification in higher education: large classes and student learning". *Higher Education*, Vol. 67 No. 6, pp. 711–719.
- Kaipia, R., Holmström, J., Småros, J. and Rajala, R. (2017). "Information sharing for sales and operations planning: Contextualized solutions and mechanisms", *Journal of Operations Management*, In press, Available online 29 April 2017, ISSN 0272-6963, <https://doi.org/10.1016/j.jom.2017.04.001>.
- Karwan, K.R. and Markland, R.E. (2006). "Integrating service design principles and information technology to improve delivery and productivity in public sector operations: The case of the South Carolina DMV", *Journal of Operations Management*, Vol. 24 No. 4, pp. 347–362.
- King, A. (1993). "From sage on the stage to guide on the side", *College teaching*, Vol. 41 No. 1, pp. 30–35.
- King, A. (1994). "Guiding knowledge construction in the classroom: Effects of teaching children how to question and how to explain", *American educational research journal*, Vol. 31 No. 2, pp. 338–368.
- Landsberger, H.A. (1958). *Hawthorne Revisited*, Ithaca, NY: Cornell University Press.
- Lambert, D.M and Harrington, T.C. (1990). "Measuring nonresponse bias in customer service mail surveys", *Journal of Business Logistics*, Vol. 11 No. 2, pp. 5–25.
- Lawrence, B., Zhang, J.J. and Heineke, J. (2016). "A life-cycle perspective of professionalism in services", *Journal of Operations Management*, Vol. 42, pp. 25–38.
- Lewis, M.A. and Brown, A.D. (2012). "How different is professional service operations management?" *Journal of Operations Management*, Vol. 30 No. 1, pp. 1–11.
- Lillrank, P. and Liukko, M. (2004). "Standard, routine and non-routine processes in health care", *International Journal of Health Care Quality Assurance*, Vol. 17 No. 1, pp. 39–46.
- Mantere, S. and Ketokivi, M. (2013). "Reasoning in organization science", *Academy of Management Review*, Vol. 38 No. 1, pp. 70–89.
- Maringe, F. and Sing, N. (2014). "Teaching large classes in an increasingly internationalising higher education environment: pedagogical, quality and equity issues". *Higher Education*, Vol. 67 No. 6, pp. 761–782.

- Mazur, E. (1997). "Peer instruction: getting students to think in class". In *AIP Conference Proceedings*, Vol. 399, No. 1, pp. 981–988.
- Meltzer, D.E. and Manivannan, K. (2002). "Transforming the lecture-hall environment: The fully interactive physics lecture", *American Journal of Physics*, Vol. 70 No. 6, pp. 639–654.
- Michaelsen, L. K., Watson, W., Cragin, J. P. and Dee Fink, L. (1982). "Team learning: A potential solution to the problems of large classes". *Exchange: The Organizational Behavior Teaching Journal*, Vol. 7 No. 1, pp. 13–22.
- Nordenflycht, A. von (2010). "What is a professional service firm", *Academy of Management Review*, Vol. 35 No. 1, pp. 155–174.
- Peppers, K., Tuunanen, T., Rothenberger, M. A. and Chatterjee, S. (2007). "A design science research methodology for information systems research", *Journal of management information systems*, Vol. 24 No. 3, pp. 45–77.
- Sampson, S.E., (2000). "Customer-Supplier Duality and Bidirectional Supply Chains In Service Organizations", *International Journal of Service Industry Management*, Vol. 11, pp. 348–364.
- Sampson, S.E. and Froehle, C.M. (2006). "Foundations and implications of a proposed unified services theory", *Production and Operations Management*, Vol. 15, pp. 329–43.
- Sampson, S.E. (2012). "Visualizing Service Operations", *Journal of Service Research*, Vol. 15 No. 2, pp. 182–198.
- Schmenner, R.W. (1986). "How can service businesses survive and prosper?", *Sloan Management Review*, Vol. 27 No. 3, pp. 21.
- Schmenner, R.W. (2004). "Service businesses and productivity", *Decision Sciences*, Vol. 35 No. 3, pp. 333–347.
- Shostack, G.L. (1984). "Designing services that deliver". *Harvard Business Review*, Vol. Jan-Feb, pp. 133–139.
- Silvestro, R. (1999). "Positioning services along the volume-variety diagonal: the contingencies of service design, control and improvement", *International Journal of Operations & Production Management*, Vol. 19 No. 4, pp. 399–421.
- Velegol, S.B., Zappe, S.E. and Mahoney, E. (2015). "The evolution of a flipped classroom: Evidence-based recommendations", *Advances in Engineering Education*, Vol. 4 No. 3, pp. 1–37.
- Wemmerlöv, U. (1990). "A taxonomy for service processes and its implications for system design", *International Journal of Service Industry Management*, Vol. 1 No. 3, pp. 20–40.
- Yin, R.K. (2009). *Case Study Research Design and Methods*. 5th Edition, Sage Publications, London.

Appendix A – Course syllabus for spring 2016

Operations Management

[course number hidden for confidentiality]

Module information 2016

Teaching Staff:

[names hidden for confidentiality]

Dear Student,

This handbook is intended to guide you through your Operations Management (OM) module. The handbook details the preparation required of you, and also supplies a list of readings that will support your journey into world of Operations Management.

Our hope is to make you like us; sad people who view the world through a lens defined by the fundamentals of Operations Management. If we are successful, never again will you be able to enjoy a meal in a restaurant or go on holiday without wondering about the processes that delivered your experience, and without looking for improvement opportunities.

We hope you enjoy your transformation!

[names hidden for confidentiality]

Contacting us:

For any queries related to the contents of the lectures, seminars, online tests, or any other general queries you are encouraged to **use [VLE] discussion boards to post your questions**. There are close to 360 students enrolled in this model therefore it is physically not possible to answer all the emails that usually ask the similar question.

We are involved in many modules and will probably meet over 800 students this academic year. It would really help us if your email contains the name of the module. E-mails with nothing in the 'subject' line or written in 'txt spk' are likely to be unread. Only for personal queries, you can contact us via email.

Face-to-face: Our access hours are on Wednesdays 15.00-17.00 (for [name hidden for confidentiality]) or Thursdays 14.00-16.00 (for [name hidden for confidentiality]). Access times mean that you can turn up without an appointment and expect to see us at these times. Our offices are located in the [details hidden for confidentiality] building; on floor 1 in rooms [details hidden for confidentiality].

Outside of these contact hours, we would advise against turning up speculatively since it is likely that we will be out. If you do need to see us outside of contact hours (and we are happy to see you at a mutually convenient time) then email first to secure an appointment. If you have any difficulty making contact, please leave a message with the Operations Management Group Coordinator, [name hidden for confidentiality].

Module objectives

The core activity of any organisation is its operations, and the performance of the organisation is determined by how well these operations are managed. This module takes a detailed look at the decisions managers need to make about operations. The module provides conceptual, analytical and practical insights into the effective management of operations in manufacturing and service organisations, in both the private and the public sectors.

Pedagogic Approach

This module will be delivered in a very different way to those you will have experienced to date. The seven major components are as follows:

On-line video lecturettes

We have created a suite of short lectures for you that cover the fundamentals of OM. We created these as we believe that some of the information you need is best packaged in this way to be absorbed at your leisure and in your own time. Classrooms are designed to be efficient for the lecturer but videos convey similar information. The classroom is best used for debate and the synthesis of information... We expect that you will come to class when an assessment takes place having at least watched the video lecturettes to prepare for the test.

Practitioner lectures

OM is – as mentioned previously - inherently a practical subject. As undergraduates most of you (you think!) have very little in the way of practical and theoretical OM knowledge. In order to allow you to more effectively connect theory and practice to understand the fundamental importance of OM, we have a number of OM practitioners giving presentations as to what OM looks like in practice. As Ops Managers lead busy lives, we have endeavored to get these locked down in advance but there may be some changes to the schedule.

In-class assessment

This is the major difference to most other modules. There will be four weeks where you have an in-class test. This IS assessed and comprises 20% of your final mark. The reasoning behind this is not down to our sadistic nature, but that it drives engagement and understanding of OM (and with a bit of luck helps you get a higher grade at the end). The tests will be delivered on line and can be done remotely. The questions are randomized, both in order and actual question and answer to minimize the possibility for collusion. Each test will be followed by a recap to provide formative feedback.

Group assessment

This, for us, is the most interesting component. It allows you to take some of the learning from class and apply them to real-life Operation of your groups choosing. It allows us to determine whether you truly 'get it' by asking you to synthesize theory and practice. We will discuss this in greater detail in class.

Seminars

There is a seminar each week where you can begin to critically use some of the learning and allows greater chance for debate. These will often use case studies from the core textbook.

Re-cap lectures

Whilst we expect you to have watched the video lecturettes, we also acknowledge that some of you will have further questions. After (or possibly before) the practitioner lectures we will have a short re-cap lecture to re-visit what you have covered.

The core textbook

You come to University to 'read' towards a degree. As such we suggest that you invest in the core text book. Also, we will use case studies from it in the seminars so without it (or good friends willing to share) you will be woefully under equipped. It's a fantastic resource and if any of you are involved in Operations in the future it will serve you well (we use it at MBA level). We also reserve the right to ask exam questions from anywhere in the textbook. This should head off the 20+ questions we get every year that ask "*Should I buy the textbook?*".

The module textbook is available at the University Bookshop and includes many of the weekly recommended readings for the module. The text [details hidden for confidentiality] and is based on many years of experience in teaching OM.

Operations Management (7th Edition) Slack, N., Brandon-Jones, A. and Johnston, R., Pearson, 2013.

Communications

Operations Management is not a subject that can be learned solely from texts and articles, it is a "live" subject and one that you need to experience. Consequently, do not expect a didactic approach, but rather be prepared to participate and to engage in debate.

Handouts, if presented, will be available after the lectures. They will do no more than provide a précis of the key issues; our expectation is that you take notes during the lecture to capture the richness of the subject. The pedagogic justification for this is that active

learning (i.e. taking notes and discussing concepts) is much more effective than sitting back passively during classes.

We ask you to raise any questions or problems as soon as they occur: If you have a problem with a concept, syndicate group work or perhaps an administrative matter, then you should raise it straight away so that we can do something about it.

[VLE] will be used as a repository for handouts, some case material and possibly some model answers. It will also be used as a discussion forum and where we will post any changes to the module. Please ensure that you check [VLE] regularly for any changes.

Teaching Staff

[details hidden for confidentiality]

Module plan

NOTE: the Module starts in Week 2 of the Spring Term.

Classes

You are to attend one two-hour lecture per week and one seminar per week.

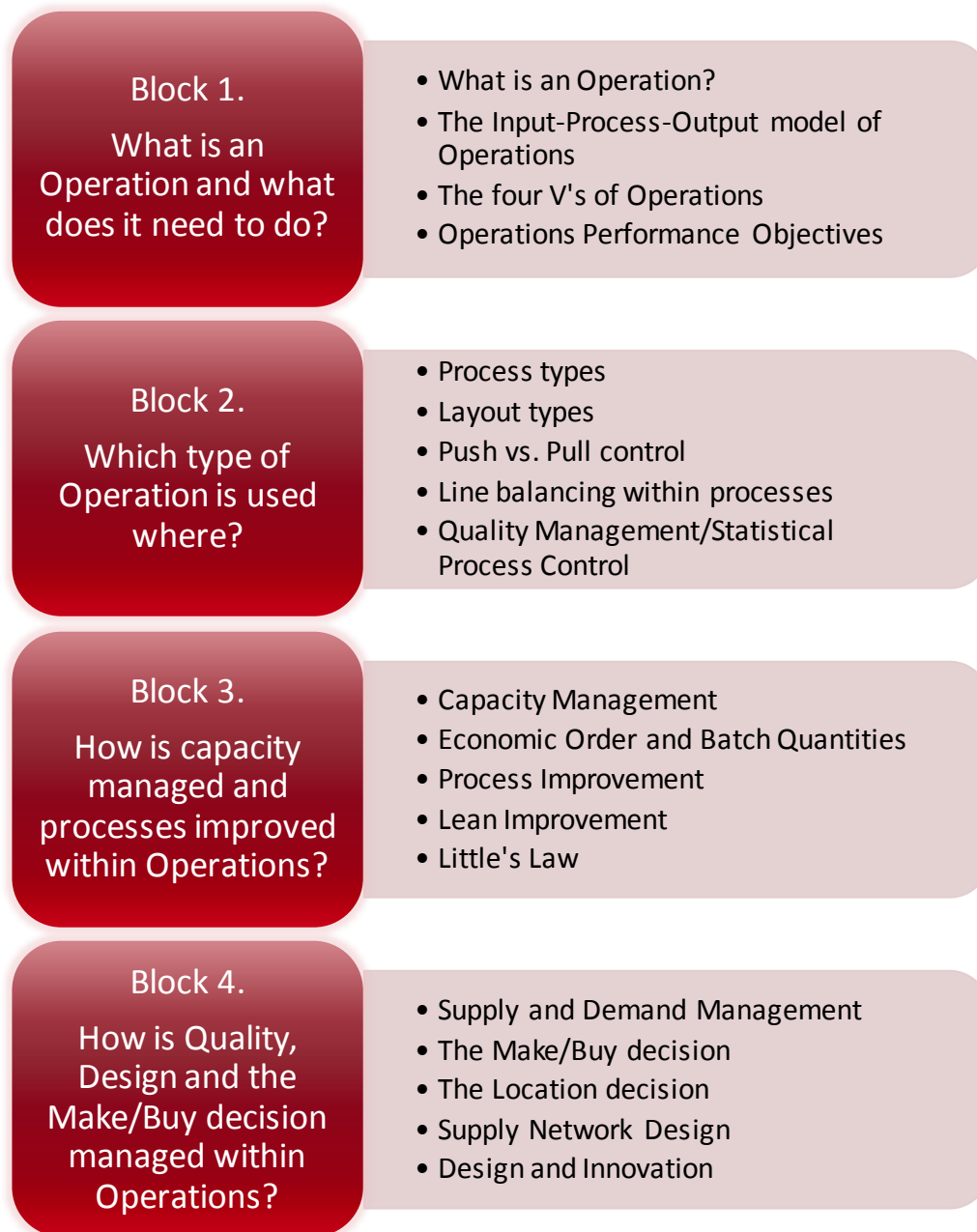
	Lectures	Seminars
Week 2	<ul style="list-style-type: none">• Introduction + Block 1 Summary• Guest lecture	<ul style="list-style-type: none">• Case Study: Concept Design
Week 3	<ul style="list-style-type: none">• Block 1 Test• Guest lecture	<ul style="list-style-type: none">• Case Study: Northwest Bank/ Assignment Brief
Week 4	<ul style="list-style-type: none">• Summary and questions for Block 2 Topics• Video Cases	<ul style="list-style-type: none">• Case Study: Dell
Week 5	<ul style="list-style-type: none">• Block 2 Test• Recap Videos on Layout	<ul style="list-style-type: none">• Practical exercise: SPC
Week 6	<ul style="list-style-type: none">• Summary and questions for Block 3 Topics• Guest lecture	<ul style="list-style-type: none">• Class Game: Paper plane
Week 7	<ul style="list-style-type: none">• Block 3 Test• Recap and Class exercise	<ul style="list-style-type: none">• Case Study: RoChem
Week 8	<ul style="list-style-type: none">• Summary and questions for Block 4 Topics• Guest lecture	<ul style="list-style-type: none">• Case Study: Paris Disneyland
Week 9	<ul style="list-style-type: none">• Block 4 Test• Recap and revision	<ul style="list-style-type: none">• Revision
Week 10	Final Revision Sessions	

Lectures

The lectures, including the tests, can be taken virtually and we will be providing links for these in due course. There is NO class in the first week and we will begin on Tuesday the 19th of January 2016. The lectures are held:

Tuesdays at 10.00-12.00 in [details hidden for confidentiality].

As detailed previously, we have created a series of short video lecturettes that discuss the substantive topics in OM. These are arranged into four blocks:



Seminars

The undergraduate office will allocate you to one of six identical seminar sessions. Please do not turn up to seminars ad-hoc but keep to your allocated slot; if you have to change the allotted seminar time (for academic reasons only), you need to re-arrange this through the undergraduate office.

Seminars will be held on Thursdays as follows, please check your seminar room and time on [VLE].

Group	Time	Room Location
1	9AM – 10AM	[details hidden for confidentiality]
2	10AM – 11AM	[details hidden for confidentiality]
3	11AM – 12PM	[details hidden for confidentiality]
4	2PM – 3PM	[details hidden for confidentiality]
5	3PM – 4PM	[details hidden for confidentiality]
6	6PM – 7PM	[details hidden for confidentiality]

Please check [VLE] for details of possible changes to seminars and rooms.

PLEASE NOTE, all preparation needs to be done before attending the seminars and we reserve the right to exclude those who have not done so from that week's seminar.

Module assessment

The formal module assessment is by group work (20%), in-class assessment (20%) and exam (60%). Formative assessment will be given by providing you with feedback on the work you have prepared for the weekly seminars and the in-class tests.

The in-class tests take the form of ten randomized multiple choice questions per test and you will be given 30 minutes to complete them. Formative feedback will be provided immediately afterwards. And the best of three individual tests will be selected out of the total 4 in-class tests.

For the group work, all groups will prepare a 10 minute video presentation (20%) as follows. The submission deadline is **Thursday 10th March**:

Using concepts, frameworks and techniques from the curriculum, undertake an analysis of an operation of your choice. The operation should be one that you have significant experience of and could be from either the manufacturing or service sector.

This will be a form of video submission. The submissions can be handed to the Undergraduate Office on a USB stick. Previous presentations have been on subjects such as: bottlenecks in a potato crisp manufacturing factory, process layout library Café, process flow at 'Cadbury World'.

Your presentation will be marked out of 20, with 15 marks given for application of Operations Management concepts, and the other five for presentation. The use of innovative and exciting presentation techniques is encouraged; PowerPoint, Prezi, audience participation, simulation,

and any other approaches can all be used. To ensure that your choice of operations is appropriate and to ensure variety, please discuss your ideas with us before starting work on your data gathering and analysis.

The remainder of module assessment (60%) is a two hour closed-book examination. Details of the exam will be provided during the term. There will be a revision session in term three.

Free-riding

In the past there have been some occurrences of students 'free-riding'. We define a free-rider as a student who consistently fails to turn up to seminars or who turns up to seminars unprepared and/or someone who does not contribute to the group presentation work. This can cause tensions within syndicate groups since students feel aggrieved when they are 'carrying' weaker members of their team who are not working. We get complaints every year from students about free-riding and we are keen to support those who are prepared to put in the effort. The University Calendar explains that:

'a student who fails to attend prescribed classes or to complete prescribed coursework may be required either:

- (a) to submit additional assessed work; or
- (b) to sit an additional written examination.

If you fail to attend seminars or fail to prepare for the seminars or group presentation, you will be given an additional assessed essay of 2,500 words to write on the following subject: *'Explain the key operations management challenges associated with running an international airport'*.

The essay (which will be in addition to the exam) will be assessed on a pass/fail basis. If you are late for a seminar you will be recorded as absent. So, consistent lateness will also result in a requirement for you to write the additional essay. So, please be prepared and on time to seminars.

Other OM books

If you want to read accessible and entertaining additional material on OM try:

"The Goal," Goldratt, E. & Cox, J., 2nd Ed, 1993, Gower Publishing; ISBN 0566074184

Perhaps not so accessible, but one that might appeal to students with science backgrounds:

"Factory Physics," Hopp, W. & Spearman, M., 1998, Irwin; ISBN: 0256247951

Finally, this book arguably put OM on the ascendant:

"The Machine that Changed the World," Womack, J., Jones, D. & Roos, D., 1991, Perennial (HarperCollins); ISBN: 0060974176