Designing a Flipped Classroom Course – A Process Model

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Abstract. *Digital learning has become more than just a trend in the modern world. Blended learning concepts are well established in different areas of application. An important concept in this domain is the so-called flipped classroom (FC). This approach repurposes class time to focus on application and discussion, while the acquisition of basic knowledge will happen at home, enabled by online lectures. In the past, research demonstrated and discussed the advantages of flipped classroom concepts within case studies. Still, standardized guidelines for the development of flipped classrooms are rare. However, it is necessary to learn from the past to improve future education. Thus, we analyzed reviews on flipped classroom research and used these to inductively develop a reference process model for the realization of flipped classroom concepts. The model is based on phases taken from project management, which help to structure the process and associated tasks. The results present the process model shown in Business Process Model and Notation (BPMN) and applicable checklists for the development of a FC course. The process model was applied and evaluated during the implementation of a flipped classroom at a university. Future research should concentrate on evaluation of the model as well as a deeper elaboration of upcoming roles and their tasks in order to derive further guidance for teachers and organizations.*

Keywords. Flipped Classroom • Course Development • Project Management • Process Model • Checklist • Business Process Model and Notation • Inductive Reference Model

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1 Introduction

The concept of a flipped classroom (FC), also known as inverted classroom, has gained rising attention over the last few years. It was at first described by Bergmann and Sams in 2006 and further developed in Bergmann and Sams (2012). The number of publications as well as practical implementations are still increasing (Bishop and Verleger 2013; Lundin et al. 2018). A common understanding of the flipped classroom is that the activities of attendance time and time outside the classroom are switched (Lage et al. 2000). Bishop and Verleger (2013) understand "the flipped classroom as an educational technique that consists of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom." The impacts of using this concept are widely discussed. Even though some approaches exist which conclude that FC does not improve class performance, compared to traditional lectures (Gillette et al. 2018; Zuber 2016), the majority of research results confirm positive impacts on student outcomes (like performance and satisfaction) as well as class participation when self-paced learning is in focus (Bishop and Verleger 2013). Until now, only small parts of lectures are held as FC. One reason for this

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is a lack of knowledge about the design of these courses. Structural research providing an overview of the topic is rare (Song et al. 2017). The dominating part of research available is case-based which leads to a "siloed" character of the research field, missing systematic approaches (Lundin et al. 2018; O'Flaherty and Phillips 2015). This paper aims to present a reference process model for the course development from a lecturer's perspective. We understand a process model as a guideline including basic tasks and milestones, which are successively being processed and are striving towards a clear goal. Theoretical guidelines can help to design as well as to use an FC and are recommended to be used for implementation (Bishop and Verleger 2013). To proceed systematically, we align the necessary steps to project management phases. We orient ourselves on an inductive reference model design (Fettke 2014) as we develop the model based on individual cases from literature. To get an overview about useful cases, we conduct a review of literature reviews about FC that is later enriched by a forward and backward search. The results are used to identify tasks and challenges associated with each phase. Additional information on important to do's and possible questions is provided. The process model is visualized using two different approaches. In addition to describing the individual phases, we model the processes by visualizing the necessary steps with the help of Business Process Model and Notation (BPMN). Furthermore, a checklist is developed for the teaching team that helps to remember all tasks that are considered useful and allows a flexible handling of the steps (Baumann et al. 2017). The usefulness of both approaches is examined in the discussion chapter. The reference process model is finally evaluated using a case study that provides further insights and experiences for the development and implementation of an FC. This article contributes to research and practice by using a structural approach from other fields of knowledge to systematize FC research. It also helps lecturers to design an FC. The focus of the article lies on the development of a useful guideline for practitioners. In the next chapters, we present the research method and summarize findings from FC reviews, which are used for the development of the process model that is presented in chapter 4. The evaluation of the model is presented in chapter 5. Afterwards, the methods used are discussed. We conclude by summarizing the findings and showing the limitations.

2 Method

We regard the conceptualization of an FC class as a process that follows all major project management phases (initialization, planning, execution and closing) according to the Project Management Body of Knowledge (PMBok) (Rose 2013). Using this concept is unusual as several teaching designs and concepts already exist (Esslinger-Hinz et al. 2013).

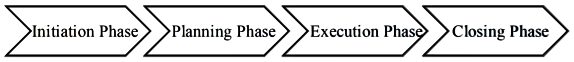

Figure 1: Project Management Phase

Teaching and traditional instructional designs (e. g., ADDIE (Helms et al. 2015)) include aspects of the competences, group of learners, and teaching subjects (Esslinger-Hinz et al. 2013). However, their dominating parts focus on pedagogical and instructional issues rather than on processual aspects (Wang 2014). The process-oriented step by step guideline is (especially in the field of FC-Design) still underrepresented (Song et al. 2017). Therefore, we chose a project management guideline and added pedagogical insights, when appropriate. We assume that this approach is easy to apply and understand due to the few phases involved. In general, different guidelines to define project phases exist and the number of phases varies (Rose 2013). Nevertheless, generic theoretical definitions can be applied to different kinds of projects. They all have in common that the phases are sequential and the degree and uncertainty are greatest at the beginning when stakeholders can best be involved (Rose 2013). We find many characteristics that are typical for projects within the creation of an FC course as the concept is new, of limited resources and limited time (Rose 2013). Using a

theoretical perspective, we define four key phases to develop, implement, proceed and evaluate an FC course (cf. fig. 1). During the initiation phase, the idea of the project comes up and has to be evaluated. Risks and impacts are considered to prepare the decision about the project's execution. In the second phase, the planning, a plan for time, costs and performance is developed. The third phase is often presented in two sections (testing and execution). It describes the integration of products or services designed in the project. The closing phase includes an evaluation of the project and its output. To get the best possible overview of current FC research, we decided to conduct a meta-review of existing literature reviews. The search was conducted in the following databases: Web of Science, Science Direct, Google Scholar, ERIC, AISNET and Scopus. We combined two search strings. The first describes FC to identify articles on the topic: "flipped classroom" or "inverted classroom" or "flip teaching". The second research string is used to limit the results to review articles. Terms used are "review" or "state of the art" or "state-of-the-art" or "meta". Both research strings are combined with an "and" function. We regard our work as a meta-analysis in the broadest sense (King and He 2005), as we did not statistically analyze the databases. The search resulted in 70 hits. Duplets and mere case-descriptions were sorted out which led to a total number of 22 articles, published between 2013 and 2018. First, we examined the focus of the reviews as well as the major findings. Moreover, we identified the kind of learners, the learning context and how the FC was implemented. The results of this analysis are used as a base to describe the state-of-the-art in FC research (chapter 3). Afterwards we used the reviews to find more literature on the topic. Based on the individual case studies examined in the reviews, we conducted a forward backward search, which led us to numerous articles on the introduction and results of FCs. All articles that showed evidence for tasks in at least one of the process phases were analyzed in-depth. In order to decide which articles are useful for identifying tasks for the phases, we used the following selection criteria:

a Tasks during FC implementation must be mentioned or described.

b It must be possible to assign the tasks to a project phase.

c The case described can be assessed as a representative example (no unusual designs).

d The article has a clear relationship to FC as a concept described by Bishop and Verleger (Bishop and Verleger, 2013).

e The results of the case described a positive influence of the FC.

Based on the findings in the review articles and the individual case studies found with the help of the forward backward search, we inductively develop a reference process model for FC development (Fettke 2014). The procedure is performed in iterative steps. In each step, the identified tasks and activities are collected, discussed and assigned to the four project management phases. This results in a description of each phase (chapter 4.1) to gain insights. Moreover, we used two different visualization approaches for our process model. First the phases are presented with the help of BPMNs (chapter 4.1) which represent the sequential process steps from the point of view of various stakeholders. As a second step, a checklist from the lecturer's perspective is presented (chapter 4.2) to gain a better overview of tasks. After the development and presentation of the process model, it was evaluated during the implementation of an FC in a business intelligence course at Osnabrück University (chapter 5). This one-case study allows to reflect the reference model in a real world setting (Yin 2014). Furthermore, lessons learned are presented, which can help other lecturers with the implementation of their own FCs. fig. 2 presents an overview of our method.

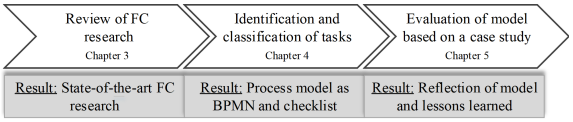

Figure 2: Research Process

3 Findings in Flipped Classroom Research

FC is a highly contemporary subject with a steady increase in publications. More than half of the identified reviews were published within the last two years, seven of them in 2018. Within our literature research, we identified 22 reviews in total. Tab. 1 gives an overview of the reviews, the number of articles studied (no.) as well as their objects and the focus of the review.

Six of the reviews are meta-studies, e. g., Hew and Lo (2018) and Rahman et al. (2014). Eight reviews focus solely on teaching in health care, e. g., Gillette et al. (2018) and Lin and Hwang (2018) and three reviews examine FC courses in engineering (Giannakos et al. 2014; Kerr 2015; Velegol et al. 2015). Within the reviews, the authors investigated a varying number of articles and case studies. Akçayır and Akçayır (2018) examined 126 articles in their review, which represents the largest sample size in all reviews we analyzed. On average, the authors analyzed 31 articles for their reviews. Most reviews have been published in the Anglo-American region and focus on the US teaching system. One exception is a meta-study by Tan examining the effectiveness of FC in China. The author concludes that the satisfaction with FC in the Chinese study is significantly higher than in the Western countries and attributes this mainly to the different (teaching) culture in China, which traditionally entails less interaction with the students and limited exchange of opinions (Cui Tan et al. 2017). Regardless of the geographical location, several authors also observe a concentration of FC approaches on STEM (science, technology, engineering, math) and health students (Giannakos et al. 2014; Hew and Lo 2018; Lundin et al. 2018). We identified two major streams within the database. On the one hand, the researchers focus on the comparison of FC to traditional lectures (Gillette et al. 2018; Hew and Lo 2018; Shnai 2017; Ward et al. 2018; Zuber 2016). On the other hand, researchers focus on the design of a flipped classroom, presenting different in-class and out-class activities (Bishop and Verleger 2013; DeLozier and Rhodes 2017; Mahoney et al. 2015). Most articles use perception (Akçayır and Akçayır 2018; Shnai 2017), performance measures or both to prove their findings. Special settings like massive open online courses (MOOCs) (Said and Zainal 2017) are also regarded.

In most of the examined FC courses, videos are used to convey knowledge before the face-to-face session, allowing students to progress according to their own learning pace (Said and Zainal 2017). The attendance time is mainly used to apply that knowledge and to encourage group work and discussions (Giannakos et al. 2014). Within the scope of digitization through FC, it is possible to introduce Learning Analytics (LA) which is defined as "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning" (Conole et al. 2011). Within the FCs, it can be used to enhance the development of targeted learning materials, monitor the success of in-class activities (Jovanović et al. 2017) and enrich the final evaluation (Lucke 2014). The majority of reviews state that FC approaches have positive effects on the success of a course compared to traditional lectures. These include increased overall performance, more cooperative learning and increased student satisfaction as the format supports discussions between students and teachers (Hu et al. 2018; Kerr 2015; Rahman et al. 2014; Ward et al. 2018). Furthermore, better learning habits and positive attitudes are observed (Giannakos et al. 2014). Nevertheless, some authors criticize the lack of control groups in many studies and state that the results of some studies are not statistically significant (Gillette et al. 2018). Due to the different design possibilities of FC courses, comparability is difficult. There are also a few articles which state that student outcomes

Table 1: Identified Reviews about FC

Source	No.	Object	Focus
Bishop and Verleger (2013)	24	students	in-class and out-of-class activities, the measures used for evaluation, and methodological characteristics; perceptions of students about FC
Giannakos et al. (2014)	32	engineering students	summarizes the benefits and focus on challenges of adopting a flipped approach in the classroom, concentrates on measure types
Rahman et al. (2014)	15	students; science, math, engineering, technology	instruments to measure the impact of FC on students' performance
Mahoney et al. (2015)	18	engineering students; higher education	focus on FC literature in engineering and case study research, concentration on in-class and out-class activities
Kerr (2015)	24	engineering students	engineering students and their perceptions about FC and the impact on their performance
O'Flaherty and Phillips (2015)	28	higher education	technology, constraints (time and economic), pedagogical acceptance, outcomes and conceptual framework
Betihavas et al. (2016)	21	health professions; nursing	role of FC in nursing
Zuber (2016)	5	students	comparison between FC and traditional lectures
Lo and Hew (2017)	15	K-12 pupils	challenges, activities and outcomes of/for students
Said and Zainal (2017)	n.a.	MOOC users	the effects of FC on students, when integrated via MOOCS
F. Chen et al. (2017)	82	health professions	measurable effects of FC in knowledge acquisition and changes in skills for medical education
Njie-Carr et al. (2017)	13	health professions	design and process information on flipped classroom models in nursing education, gives the state of the evidence to inform the implementation of FC, and derivation of future research recommendations
Cui Tan et al. (2017)	29	health/nursing professionals	evidence about the effectiveness of FC in nursing education concentrating on critical thinking and problem-solving skills, self-learning abilities and satisfaction
DeLozier and Rhodes (2017)	n.a.	not limited	shows variety of in-class and out-class activities and their effects on learning performance
Shnai (2017)	49	students	articles that present FC or compare the FC with traditional lectures; focus on reported gaps, drawbacks and challenges, derived from students' and faculty' feedback
Gillette et al. (2018)	11	health professionals	compares student outcomes using flipped classroom versus lecture and by using the final examination score or final course score
Hu et al. (2018)	11	health professions/ undergraduate students	quantitative comparison of results regarding effects on theoretical knowledge improvement and skills
Hew and Lo (2018)	28	health professionals	effects of FC with pre-recorded videos compared to traditional lectures
Lundin et al. (2018)	31	higher education	state of the art regarding the FC settings; FC research is often about STEM and in HE settings
Lin and Hwang (2018)	45	health professionals	in-class and out-class activities and the learning level appealed
Ward et al. (2018)	14	health/nursing	focus on learning outcomes and improvements comparing traditional and FC course design
Akçayır and Akçayır (2018)	126	students	advantages and challenges for both students and instructors

are not better in FCs compared to traditional teaching methods (Gillette et al. 2018). Accordingly, new approaches for the evaluation of FC courses which unequivocally prove the success of FCs, are needed (Lin and Hwang 2018; Zuber 2016). Moreover, the high initial costs and set-up times incurred when implementing an FC course, especially for the lecturers, are not yet sufficiently investigated (Giannakos et al. 2014; Lo and Hew 2017). In sum, most reviews show the results of delimited case studies that focus strongly on individual disciplines. This leads to a siloed and perhaps anecdotal knowledge in the research field without any systematic approaches. Therefore, a more general systematic examination of current research is necessary (Lundin et al. 2018; O'Flaherty and Phillips 2015).

4 Process Model for the Design of a Flipped Classroom

4.1 Tasks in project management phases

In the following chapter, we will describe the activities to be carried out to run an FC course. Fig. 3 shows the project phases and the respective milestones to mark the (intermediate) results of each phase. The milestones will be described in detail within the following chapters. This summarizing overview provides the structure to understand the separate actions taken in each phase.

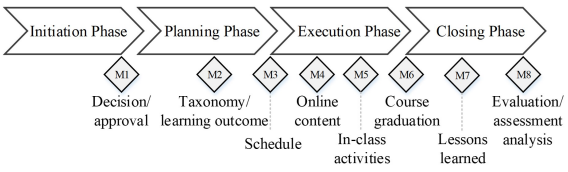

Figure 3: Milestones

The description of the activities in the phases is supplemented by BPMNs, which enable a sequential view of tasks as well as assign the tasks to the stakeholders. As FC development is regarded to be executed rather by teams than by individuals (Tucker 2012), the term "Teaching Team" will be used as one lane in the BPMNs. It represents all lecturers involved as well as assistants and tutors for the FC. Another BPMN lane/pool used is "Administration". It includes all supporting positions at the university like finance or IT departments. Some phases also include the lane "Students" which can refer to the students of the course, of the university in general or of interdisciplinary groups such as the student council or union. The pools used in each phase can differ, as only participants with tasks were modelled.

4.2 Initiation Phase

The initiation phase aims to prepare a basis for deciding whether a course should be redesigned (or newly created) according to the FC method. The objective of the phase is to make an informed decision on the usage of an FC taking into account various stakeholders and limited resources. Reasons for the redesign or creation of an FC could be the discontentment of teachers or students. The difficulties and problems of the current form of the lecture are investigated. Then solution proposals should be created, in this case, the transformation of the teaching form by the implementation of FC. The teacher first has to gather knowledge about the FC method in general, as well as about its advantages and disadvantages. The FC method can, for example, increase the student's motivation, performance, attendance and interaction during face-to-face sessions (F. Chen et al. 2017; Kerr 2015). But it must also be considered how time and costs consuming the implementation of an FC can be. One method, that is crucial in the initiation phase, is the stakeholder analysis. The affected stakeholders, as well as their benefits, challenges and barriers (Rose 2013), must be identified. The stakeholders usually are the lecturers (including professors, teaching assistants and tutors), students and the organization itself. All groups of stakeholders must be provided with the information needed. Teachers should familiarize themselves with the concept and may have to deal with a lack of skills and resources (Lo and Hew 2017; Shnai 2017). Implementing an FC requires much effort,

especially at the beginning, as the entire course has to be arranged in the FC format (Giannakos et al. 2014; Mason et al. 2013). Moreover, technical obstacles like cutting and uploading videos or the provision of self-learning tests on online platforms must be overcome (Lo and Hew 2017). Students can be actively involved in the redesign of the course by incorporating their feedback and ideas. Apart from teachers and students, stakeholders within the organization should also be addressed, such as administrative staff or IT support (Enfield 2013). The administration can help teachers to examine if the redesign or creation of an FC is in line with the universities regulations. At some universities, there are competence centers for virtual teaching or higher education didactics, which accompany the conversion of courses and provide expert advice. Additionally, most organizations have a learning management system that can be used to make the multimedia files available to learners. Before being able to make an informed decision about the implementation of an FC, it is important to estimate the cost of the resources. Resources include people, equipment and materials. Methods used for planning the resources can be bottom-up estimating or using expert judgement (Rose 2013). It should be checked which resources are already available, which additional resources are needed, and how much has to be spend for new acquisitions (e. g., learning management systems (LMS), video equipment) (Giannakos et al. 2014; Lo and Hew 2017). Teachers should consult with the administration as additional funds from the university or third parties may be required. Since FC is not a "one-man" project (Arnold-Garza 2014), a team must come together to develop the course. It has to be planned what and how much each team member can contribute to the project. Depending on the human resources available, the team can consist, for example, of lecturers, teaching assistants, project managers, student tutors and IT staff. We call this the teaching team (BPMN in fig. 4). There is only limited structured information about the activities and tasks of pre-learning available for the training of the teachers, but Balan et al. (2015) offer a method that can serve as a guide.

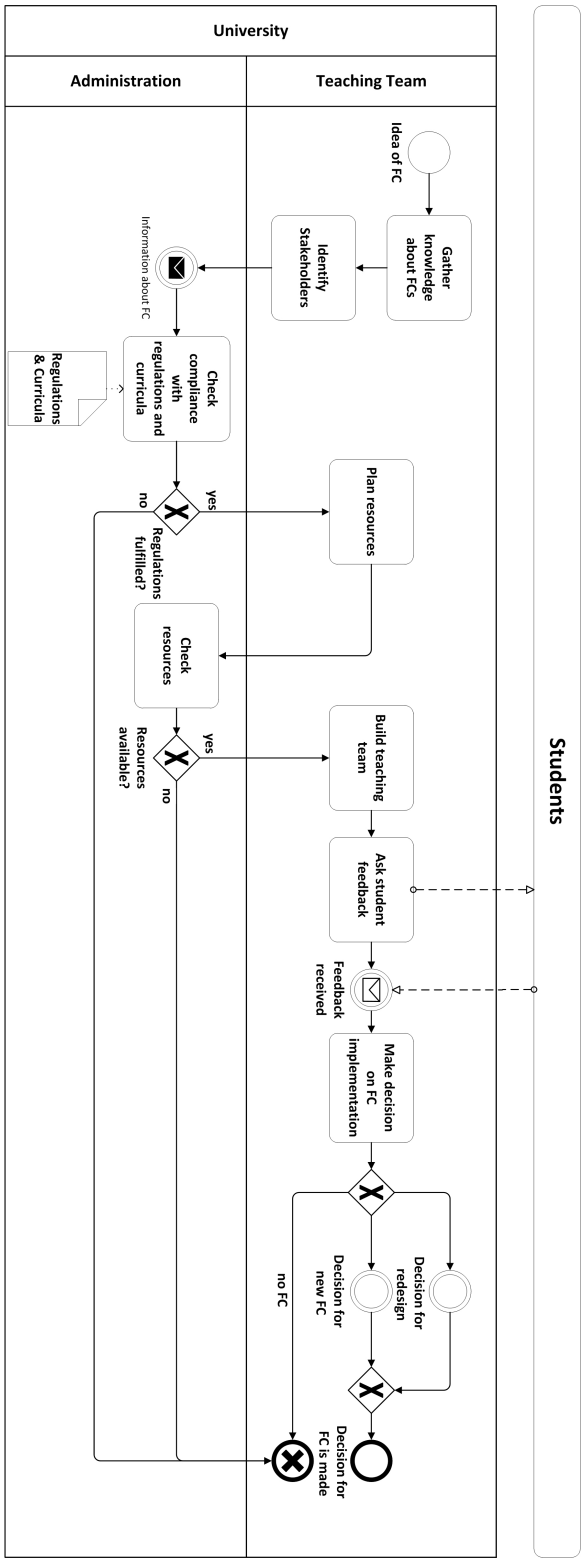

Figure 4: Initiation Phase

The result of the initiation phase is the decision (M1) for or against the implementation of an FC. After the need for an FC has been identified and the stakeholder analysis as well as the first rough planning of resources have been completed, the teaching team has to decide whether the benefits of FC merit the time and financial investments. If so, the implementation of an FC can either be transformation of an already existing course (redesign) or the creation of a completely new course.

4.3 Planning Phase

When the decision is made to implement the FC, the second phase begins. The objective of this phase is to plan the flipped classroom in general (adjustments to the curriculum, set the timetable, etc.) and in detail (design and tuning of the lectures). A lack of time is one of the most threatening challenges (Lo and Hew 2017; Tucker 2012). Therefore, thoughtful planning is essential (O'Flaherty and Phillips 2015) for the success of the FC. The teaching team needs to get and give information before the execution about needed adjustments in curricula as the course (format) could also impact these (Fulton 2012). It should also be checked if possible methods used for the FC meet the university's requirements, e. g., examination regulations. If the contents or the form of exams (e. g., digital exams) are to be changed in the context of the conversion, compliance must be ensured. This is also closely related to the learning outcomes which the lecturers want to achieve within the course. Learning taxonomies (M2) are useful to structure the goals of the course (Hu et al. 2018; Vogelsang et al. 2017b) and are therefore an important milestone in order to implement an FC. They are applied to split the content into reasonable sections and enable the tuning between the online and in-class courses (Vogelsang et al. 2017a). There are different designs that represent a full flip or partial flip (Bishop and Verleger 2013). Furthermore, they reflect the different learning levels (Anderson and Krathwohl 2001).

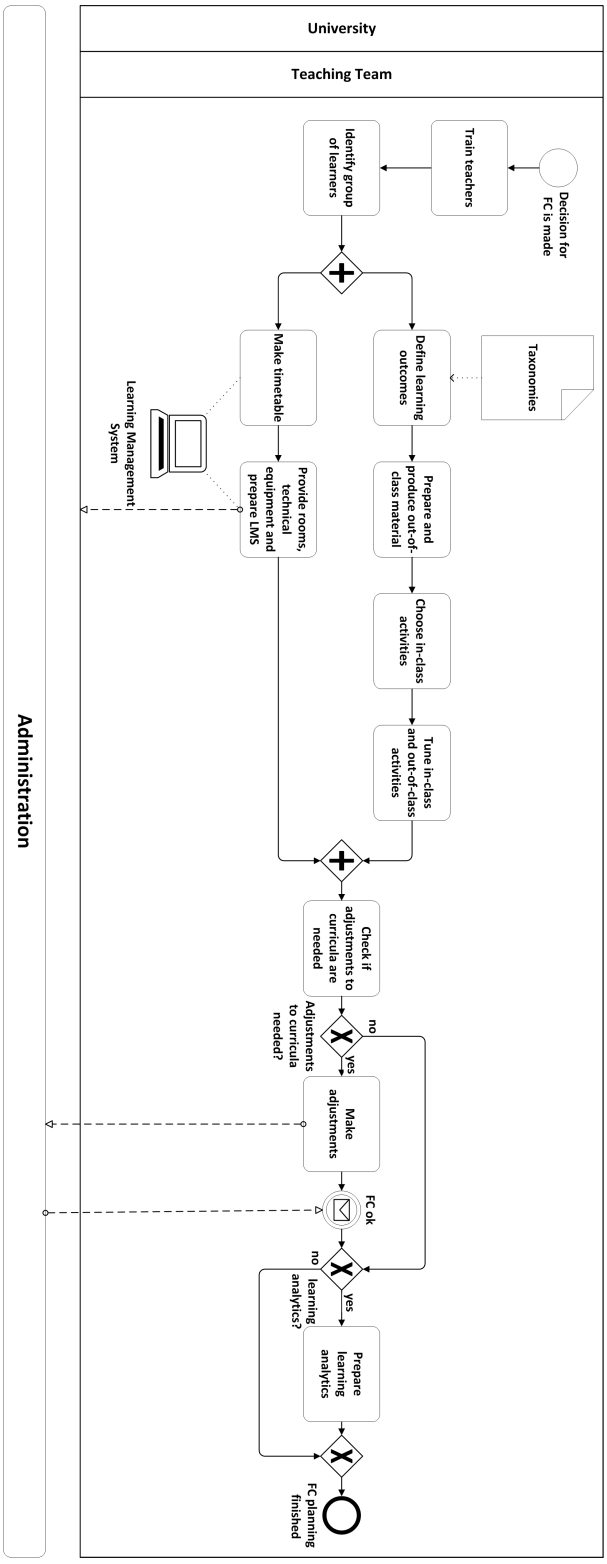

Figure 5: Planning Phase

As the online-videos often cover basic contents, the in-class courses can be used for application, discussion, problem-solving and collaborative learning (McLean et al. 2016). In this context, it is important to identify the group of students who will be taught. Teachers can develop FC classes for pupils, undergraduates (McLean et al. 2016), higher education students (O'Flaherty and Phillips 2015), and specific professional groups (Betihavas et al. 2016) from different disciplines. Furthermore, different learning types need to be considered (Bishop and Verleger 2013). The development of the FC can be improved if the teaching team is aware of the diversity of the class. Gender differences can affect students' perceptions and learning outcomes (S.-C. Chen et al. 2016). To convince students of the new method, the concept of FC should be explained beforehand, including the content, goals and the procedure (Lo and Hew 2017). For the quality of the learning, the design of in-class and out-of-class activities is very important (Shnai 2017; Velegol et al. 2015). Pre-class online lectures are of great value if they provide students with the basic knowledge to proceed with interesting in-class actions (Tucker 2012). For the time out of class mostly prerecorded video lectures, podcasts or screencasts are used (Bishop and Verleger 2013; DeLozier and Rhodes 2017; Velegol et al. 2015). Herreid and Schiller (2013) surveyed FC teachers, with the result that most of them either chose sources like the Kahn Academy for precasted videos or produced the videos themselves, using tools like Camtasia or apps like Educreations and Explain Everything. The materials for selfmade videos (e. g., slides) need to be planned beforehand (O'Flaherty and Phillips 2015) and produced step by step (Grypp and Luebeck 2015) before providing them to the students. For this purpose, subject areas have to be divided into several online contents (Arnold-Garza 2014). As students can get easily distracted (Zappe and Leicht 2009), it is recommended to use videos with a length of ten to 20 minutes (Velegol et al. 2015). The videos can be posted on platforms like YouTube, iTunes U, or on LMS like Blackboard and Moodle (Herreid and Schiller 2013). Lecturers should stay in contact with the IT support (Enfield 2013; Lo and Hew 2017) to guarantee easy access for the students (Jensen et al. 2015). It has proved to be beneficial to use existing technologies rather than developing new ones (Demski 2013; Findlay-Thompson and Mombourquette 2014). As questions from students cannot be asked immediately (Natalie B. Milman 2012) forums can enable discussions on the video content (Bhagat and Chang, Cheng-Nan and Chang, Chun-Yen 2016). Regular quizzes that mirror the video content help to reduce distraction and ease the preparation for in-class activities (Velegol et al. 2015; Zappe and Leicht 2009). Out-of-class activities can be complemented by homework, pre-readings, automated tutoring systems or supplemental videos (DeLozier and Rhodes 2017; O'Flaherty and Phillips 2015). Besides the planning of online lectures, teachers need to decide which methods should be used in-class and prepare materials if needed. The teaching team has to keep in mind that the pre-class preparation of an FC is much more time-consuming and complex than in traditional courses. Researchers calculate the expenditure with approx. 1-2 hours per unit (Mason et al. 2013) and altogether 100 hours per course (Vazquez and Chiang 2015), whereby there is also the possibility of using already existing lectures (Vazquez and Chiang 2015). During the planning phase, a decision should also be made as to whether Learning Analytics (LA) are to be used and whether the technical and personnel requirements are met. The administration and the affected students must be informed and consent to the use of LA within the framework of existing data protection laws. If the teaching team wants to use LA, they also have to decide which data should be analyzed (e. g., trace data of the LMS like activation of course videos or solved online assessments), how the data will be analyzed and how and for what purposes the results will be used (Jovanović et al. 2017). Apart from FC specific planning, regular activities like scheduling in-class time and the reservation of rooms are necessary. The transition to the third phase takes place when the planned course starts. This is only

possible when the milestone of scheduling (M3) as well as the whole planning activities are finished so that the course has a general structure. For an overview of tasks cf. fig. 5.

4.4 Execution Phase

The actions proceeded during the term are subsumed within the execution phase. The objective of this phase is the actual proceeding of the learning and teaching. This means the phase mainly aims at the supply of the video tutorials (M4) and the proceeding of the in-class lectures (M5). This phase is the one with the highest interaction between the students and the teaching team. This means the rules of the FC and additional information about this teaching method must be communicated beforehand (Balan et al. 2015), for example in a kick-off meeting, as students are generally less satisfied with unclear instructions and unknown situations (Lundin et al. 2018). The FC success depends mainly on the student's compliance (Bergmann and Sams 2012; Lo and Hew 2017). There is a great variety of tools and methods available, that can be chosen for the in-class activity in FC settings. In-class courses can be designed as homework, quizzes, lectures, small group activities, presentations (e. g., case-based, student) and discussions (e. g., team-based, panel or expert-led) (Bishop and Verleger 2013; DeLozier and Rhodes 2017; O'Flaherty and Phillips 2015). The activities chosen are very important as they differ in their effectiveness and conditions needed (DeLozier and Rhodes 2017). If the major goal is to enrich materials in class, more lecturer-oriented activities such as teacher-led discussions are useful. Interactive group work can be more suitable for the application of the material. Moreover, the course size has to be considered. While videos can be used for different group sizes, including large groups (Lehmann et al. 2015), the attendance time needs to be planned more carefully for larger groups, for example by forming smaller groups and/or using peer-learning (Danker 2015; Vogelsang et al. 2017a).

Attendance time activities are often accompanied by smartphone apps, pair-and-share activities

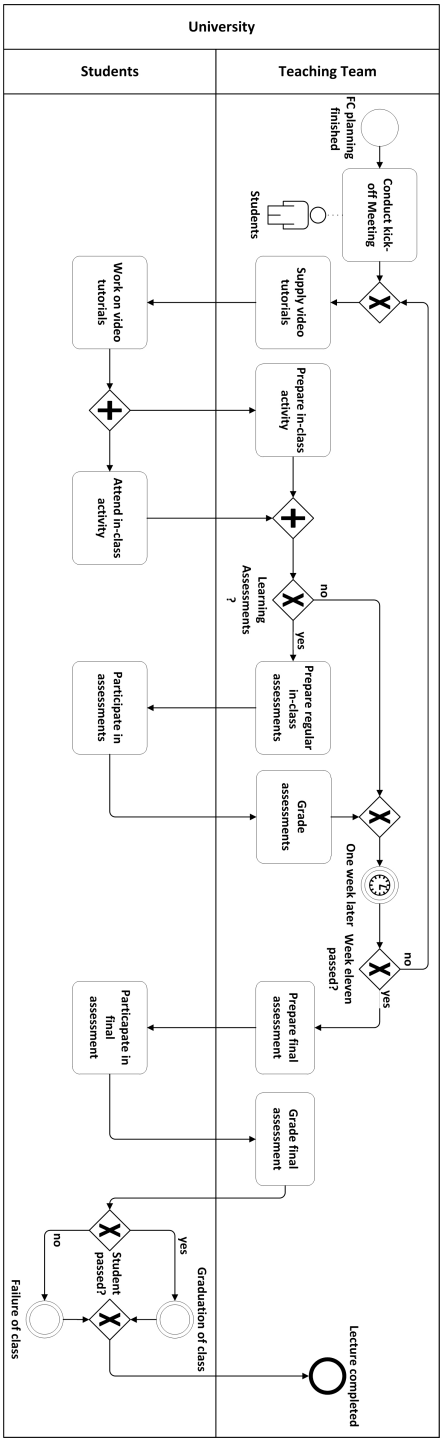

Figure 6: Execution Phase

or clicker assessments for immediate feedback to bridge expectations (Balan et al. 2015), misunderstandings and knowledge gaps (O'Flaherty and Phillips 2015). Furthermore, accompanying in-class assessments makes it possible to test previous knowledge and ensure quality and continuous learning (Demski 2013). Mid-term assessments are a common technique to evaluate learning success (Velegol et al. 2015). In-class and online-assessments complement the flip model (Demski 2013). Therefore, clear accordance of video tutorials and in-class content (and assessments) is essential (Lundin et al. 2018; Strayer 2012). The kind and tone of interaction are important for the satisfaction emphasized by the learners (Findlay-Thompson and Mombourquette 2014). The original FC model was designed as a flipped mastery model with little peer interaction and a focus on individual learning (N. Foldnes 2016). The role of the teacher changes in an FC environment (Bergmann and Sams 2012; Zappe and Leicht 2009). Recently, the share of team-based learnings and high group interaction increased (Balan et al. 2015; N. Foldnes 2016). In team-based learning settings, the material for the in-class courses is processed iteratively. First, the individual student works with the material; then the individual results are discussed within the groups and finally debated with the teacher and presented in class (Balan et al. 2015; N. Foldnes 2016). These iterations seem quite time-consuming to the students and can lead to a resistance to change (Balan et al. 2015). In the worst case this results in absence from class. Some students also regard the in-class courses as obsolete, as they can learn the basic content of the class online. However, as intended by socio-constructivists, the group based learning in FC courses is essential for learning success (N. a. Foldnes 2017). Furthermore, the total student-workload should be considered at all times throughout the execution phase (Vogelsang and Hoppe 2018). The teaching team must permanently control and steer the course regarding the students' needs, the planned results and the amount of work. It is important to keep in mind that students usually need more time to prepare for an FC course than to follow up on traditional lectures. It is therefore an important task to motivate the students to work through the online content and participate in class. This requires the implementation of appropriate methods, for example the use of gamification. This approach can be beneficial if it corresponds to the motivational structures and preferences of the students (Schöbel and Söllner 2016). Short quiz questions to enter the next content of the online content or competitions between students can be useful to make self-study of class content easier and more appealing (Lo and Hew 2017). One focus in FC research lies on the advantages for students, attending FC courses. The chosen measures often concentrate on the learning success (Ward et al. 2018) as the result of this phase. In many studies learning success is directly linked to the exams (Gillette et al. 2018)). An FC design does not inevitably lead to a change in the way exams were carried out (Anderson, Jr., H. Glenn et al. 2017), but the high interaction and the available technical infrastructure enable changes (Velegol et al. 2015). Exams focused on problem-solving (Bates and Galloway 2012) or including bonus points (Vogelsang and Hoppe 2018) occur. Only few studies also regard gains on a meta cognitive level like critical thinking (Cui Tan et al. 2017). In many cases exams mark the reaching of this milestone. The execution phase ends with the graduation of the course (M6), as shown in fig. 6. This milestone marks the end of the interaction between the teacher and the students.

4.5 Closing Phase

The final phase of the FC process model is the closing phase. The objective of this phase is to evaluate the course, collect perceptions about the FC construct, content and overall implementation. The closing phase includes the analysis of data obtained on results and perceptions. The chosen methods differ with respect to their focus. The analysis is based on the teacher's experience, exam results and measurements of the students' attitude towards the concept (Vogelsang and Hoppe 2018).

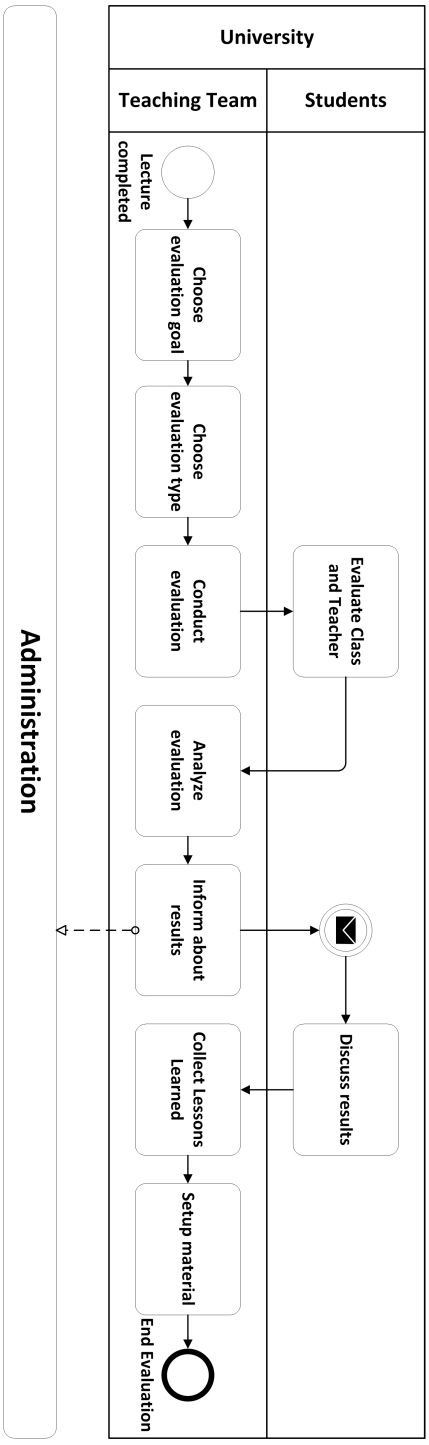

Figure 7: Closing Phase

Therefore, differentiation between summative (to measure the outcome) and formative (to formulate the lessons learned and re-design the concept) evaluations is necessary (Vogelsang et al. 2017a). Most evaluations in FC research are based on self-reported scales using quantitative and qualitative data (Velegol et al. 2015). These scales often comprise perceptions of feelings, subjective experiences and satisfaction (N. a. Foldnes 2017). Furthermore, the evaluation of the learning success (O'Flaherty and Phillips 2015) and the students' effectiveness are important (F. Chen et al. 2017). Many researchers claim the increase of the learning success using an FC scenario (McLean et al. 2016). Often the students' performance as a whole increases in FC classes compared to traditional lectures (Hibbard et al. 2016). Kerr mentions that even the middle and the lower third of the examination group increase their performance (Kerr 2015). These results mainly aim at the exam-outcomes. Further positive statements regarding the problem-solving ability of students exist (Rahman et al. 2014). Only a few studies show opposite results (Lo and Hew 2017). Despite the measurable learning success, Foldnes (N. Foldnes 2016) shows, that the increase of group interaction positively influences the learning outcomes. The great variety of evaluation designs shows that there is no standard tool for assessing FC neither formatively nor in a summative way. The evaluation can be further supplemented by LA, providing deeper insights into student's interaction and behavior throughout the whole course (Jovanović et al. 2017). Only a few articles can be found that give room for the lessons learned (M7) to develop a sustainable culture of FC classes (Hew and Lo 2018) as a comparable result of this phase. Teachers should use the closing phase to reconsider the contents and continuously work on the renewal of the contents and methods. The pre-recorded online material should be critically revised (O'Flaherty and Phillips 2015). In the FC process, the time made available for post-processing is limited. Nevertheless, it is important to collect thoughts, write down lessons learned and restructure future classes for sustainable success. These steps can improve the FC by design based approaches (Hew and Lo 2018; Lo and Hew 2017). This phase is finished with the assessments

and evaluations (M8) which are held and analyzed. Results are shared with the organization and used for formative and summative re-organization of the course. For an overview of the steps, cf. fig. 7.

4.6 Deduction of a Checklist

In the preceding sections, the activities for each phase are described in detail and BPMNs for the visualization of the processes are used. We regard this as a very detailed view on the tasks to be completed by the lecturers and the supporting parties. So, a shorter guideline for the activities from the view of a teaching team (as the major drivers of the FC) is presented in this chapter. We regard a checklist as a useful method to get an overview on the great variety of decisions as well as tasks during an FC development. Moreover, they are easy to understand and handle (Baumann et al. 2017) as checklists are used in everyday activities and do not require background knowledge. The checklist includes the major tasks for the teaching team per phase (cf. fig. 8). These were identified and collected by all authors. The checklist helps the team to know what to do in each phase. However, the order of tasks is not set when working with the checklist, which leads to a higher flexibility. When to perform each task is left to the lecturers. The only structure of the list is given by the assignment of tasks to the project management. For the application in FC courses the teachers can adapt the list quickly to their needs and by doing so bring in own ideas for the development. We regard the list more as an orientation and overview of major tasks in literature (cf. fig. 8). It should be helpful as an instrument but contents could vary in other cases (e. g., if lecturers already know that FC is in accordance with the university requirements).

5 Evaluation

For the evaluation, we set up an FC for students using the developed process model in order to gain insights about the usefulness of the model by deriving own experiences and to further concretize the individual steps. Moreover, we intend to interview FC teachers and students about our model and checklist in order to review our results and expand the model. A large and diverse set of data relating to the project management-centered design of an FC could provide interesting information that would allow the model to be evaluated and benefits and barriers to be compared under different conditions and for different stakeholders.

5.1 Description of the case

For the implementation of an FC and the evaluation of our process model we chose to redesign an undergraduate Business Intelligence (BI) course at Osnabrück University. The BI course is a 10 credit undergraduate elective course for Business Administration (BA) students and a compulsory course for Information Systems (IS) students. Contents of the course include data modeling, data warehousing, analytics, and information design. Before the transformation of the course in 2018, the contents were taught to the students in 180 minutes of traditional lectures per week, spread over two dates. Students were also given weekly exercises, which they were supposed to solve by themselves in the computer labs. The final exam used to be a two-hour written exam, which accounted for 100% of the final grade. There was a clear need to redesign the course as the results of students' evaluations scored below the university-wide average for years and teachers faced challenges such as low attendance and high dropout and failure rates. Further discussions with students led to the realization that the main problem was not the contents of the class but the style of teaching. One reason for this is the fact that students have individual learning styles and times. Regarding this course, they also have different levels of prior knowledge. While all students have already completed the course "Introduction to Information Systems", only the IS students had programming and database management courses. Without the specific prior knowledge, for example about data types, it was hard for many BA students to follow the lectures while IS students often complained about the slow pace and too many repetitions. Irrespective of the subject they studied, students criticized that they had problems concentrating

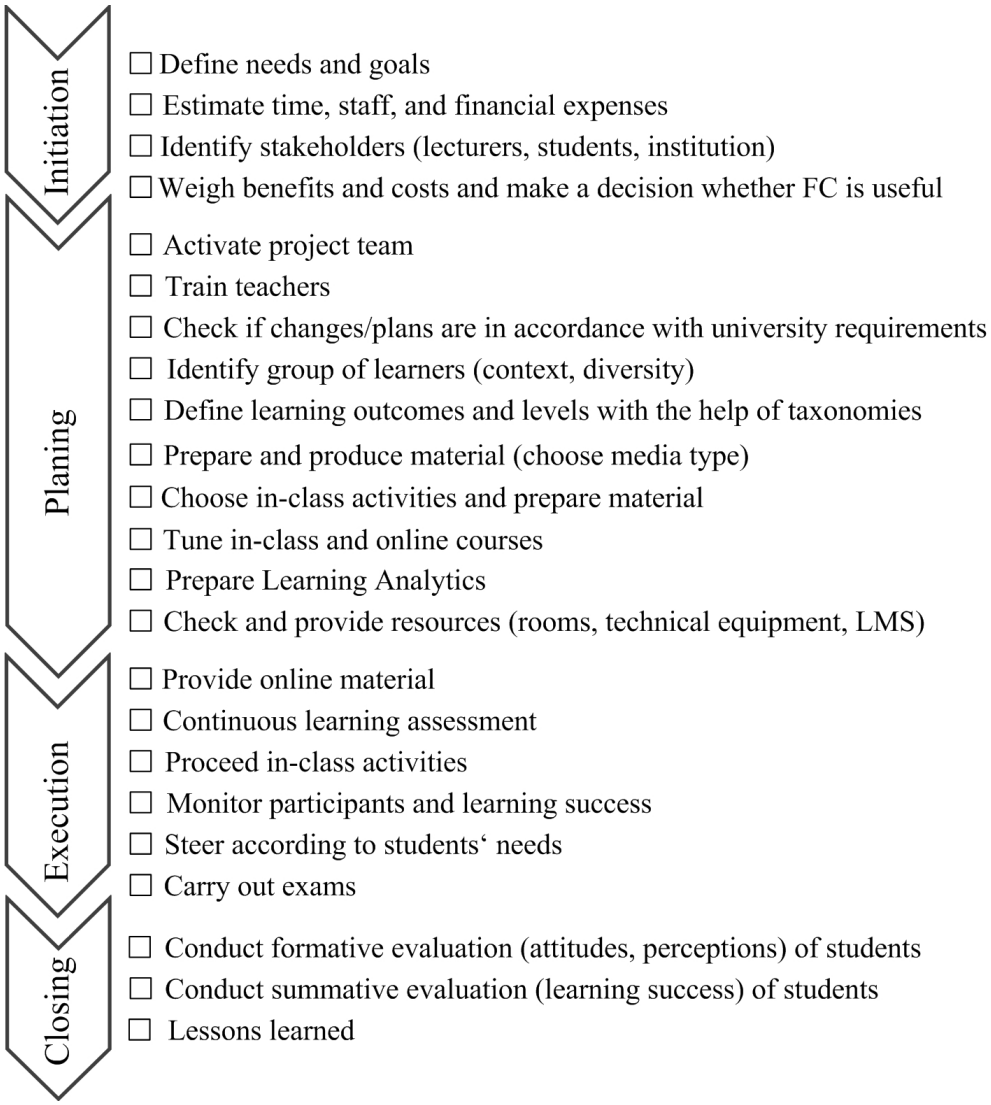

Figure 8: Checklist

throughout the entire 90 minutes of lecture and that they did not feel able to transfer their knowledge outside of the classroom, when they tried to solve the homework in the computer labs. It was very difficult for the teachers to motivate the students. The results of their homework were often below the expected level and participation in the course was consistently low. Because many students did not complete the homework at all and only rarely attended the lecture, they quickly lost touch and almost half of the BA students dropped out. However, students also said that they find much of the content of the course interesting and relevant for their future professions. Especially the strong practical relevance, for example by using current software and the inviting guest speakers from big companies were positively emphasized by the students. By transforming the course to a FC, our goal was to not only balance the learning and knowledge differences of the students, but to make the course as a whole more interactive and interesting as well as to strengthen soft skills such as teamwork and independent learning. Our goal was also to reduce the drop-out and failure rate,

increase attendance and grade average, as well as achieve better results in the final evaluation. We wanted to further expand the aspects of the course that the students regarded as positive by further expanding the practical relevance. In order to learn more about FCs in general we conducted a literature and internet search first. Afterwards, we met some teachers from our and other universities who already (partially) used FCs. We also took advantage of free training from the universities internal Centre for University Didactics. We started our own FC planning by identifying the stakeholders, i. e. teachers, students and administrators and we interviewed them to uncover their perceived benefits and barriers. During the presentation of the FC concept to the members of the student union, 80 out of 81 students were in favor of converting the course into an FC. The administration also supported the plans from the beginning, as long as we would not need additional funds, as these were not available at that time. For the conversion, we calculated the support in the form of six students with 25 hours per month each and a part-time research assistant. We also had to purchase cameras, microphones, the software for video cutting (Camtasia) and additional computers for the student tutors. We decided to use the university's LMS StudIP, which offers two AddOns (Courseware and VIPs) for e-learning classes. We planned a time horizon of seven months for the conversion and calculated a cost estimate of 40,000 €, which could be financed thanks to a successful third-party funding application for the digitization of German university courses. Our own teaching team therefore consisted of one professor, a teaching assistant who was also the project manager, another part-time research assistant and six students. The implementation of the FC, however, had to take place during the semester, as our teaching commitments throughout the year are so large that we could only plan a lead time of one month for the project. Therefore, the planning and execution phase did not occur sequentially but rather simultaneously. In a meticulous project plan, we planned the entire semester in such a way that the online and attendance parts would each be completed one week before their implementation date. For each week, we set overall learning goals and divided them into smaller learning objectives. We then planned three to four 10-minute videos and 90 minutes of attendance time for every week. We were never able to plan more than two weeks ahead of time. One of our main priorities was to align the level of knowledge of all enrolled students without overwhelming or demanding too little. Therefore, each video was presented on its own Courseware page, where students could also find the learning objectives of that section, a detailed description of the content, the video itself and a summary of the most important statements. At the bottom of the page, students could test their own knowledge using multiple self-assessment questions. During the first two to three weeks, most students read the summaries and tried to answer the questions to assess themselves. Afterwards, they only watched those parts of the video they had not yet fully internalized. Students who needed more time to understand the content could proceed in their own learning pace and, if needed, asked questions in the discussion forum. Regardless of how quickly the students processed the offline content, the only condition was that they had completed this by the attendance time a week later. Planning and conducting the attendance time proved to be much more time consuming than expected. We divided the students into smaller groups and offered seven time slots a week. The attendance time was held in the computer labs, where students, together with their instructors, worked in groups to apply the theoretical knowledge in current market-leading software such as Informatica and Tableau. The graduation of the course changed from a single final exam to a mid-term exam in combination with a final exam so that the workload is spread over time. Students were also able to collect bonus point for the exam by handing in correct homework assignments.

5.2 Lessons learned

The process model proved to be very helpful throughout the conversion. First, it was useful to

have a visual overview of the whole process when the teaching team came together for the first time. We were also able to assign the tasks according to the steps in the BPMNs. Especially the information gathering time during the initiation was very helpful. By talking to FC experienced teachers and getting an overview of the state-of-the-art of a FC, some tripping hazards were identified straight away. Throughout the planning and implementation, we used the checklist to make sure we did not forget anything important. We were easily able to adapt the process model to our own needs. Because we redesigned the lecture throughout the running semester the planning and execution phase always happened simultaneously. It gave us the chance to work more iteratively than presented in the process model and we also evaluated each week. Moreover, we were able to continually improve the online and offline content for the following weeks. This iterative procedure was supported by the checklist as it has no clear order of tasks. The BPMN was more useful for sequential steps. The process model gave us orientation and insights from current research at all times and we think it was one reason why our FC was successful. We benefitted from practical insights regarding useful tools for FC development. Camtasia has been proven as useful for the preparation of video material. The combination of videos, explanations and questions within the LMS resulted in positive student feedback because they could plan the learning individually. Out of a registered 190 students, 155 finished the course. We were able to reduce the dropout rate of students from 40% to 23%. The failure rate dropped to an all-time low of 12% and the grade average improved from 3.3 to 2.7. 106 of our students filled out a voluntary questionnaire at the end of the semester, 18 IS students and 88 BA students. The majority of the students was happy about their decision to take the class and 85% of students would recommend the FC concept to their fellow students. However, some challenges also came up. Our students were not used to working interactively and we have to take into account when designing the course that students need some time to get used to the new course format. They were very shy to answer questions and some of them rejected working in groups. In conversations, however, the students expressed themselves very positively about the new concept. With the help of an introductory event on the FC method and continuous feedback from the students, we hope to see a positive attitude from the students towards the redesign of the course. Besides these challenges, we reached the goals we set and are very content about the implementation. Without the funding of the project we would have hardly been able to redesign the course so fast and efficiently. Converting a lecture throughout the running semester is quite stressful and needs meticulous organization. However, it also gave us the chance to incorporate student feedback right away, as we have never planned more than two online-lectures/ attendance times ahead of time. Surprisingly for us, planning and executing the attendance time was more complicated and time costly than everything else. We are still experimenting with the methods we use during the attendance time. In general, there is still some room for improvements. Due to the time constraints, we were not able to implement everything we planned. For example, we still want to shoot more videos about how to use the software, we are planning to interview employees from companies in our videos to give the students more insights into the practical word, and we also requested multiple new features for our LMS because we were, for example, quite limited with the tasks we were able to design for the learning assessments (e. g. students were not able to draw).

6 Discussion

To develop our process model, we used inductive reference modelling techniques, which means that the model is based on individual case models that are analyzed according to similarities and used for abstract reference model development. In contrast, deductive reference models can be used. This approach builds upon general principles and theories, which are further concretized and used for specific cases. The deductive method is much

more common in reference modelling techniques (Fettke 2014). However, for our study we regard the inductive approach as useful because many interesting cases about FC development already exist in literature. To use this knowledge and build on experiences of numerous cases can be beneficial for reference models. We believe that the collected results from research in one reference model not only ease the implementation of a FC, but also enables new FC designs, so that the general model presented can lead to new individual application scenarios. Advantages regarding inductive modelling compared to deductive modelling can also be found in the article by Rehse et al. (2017). For example, general principles and theories do not have to be identified for inductive reference modelling. It is also expected to be better in detailing, maturity as well as acceptance. We see two challenges in the application of inductive modelling: First, the input from cases is usually associated to one organization because it is important to be able to compare the input data (Rehse et al. 2017). This was challenging for us as this was not the case with the literature reviews we used. Therefore, we had to develop a procedure to handle various articles from different sources. This was done by independently reading and analyzing the articles by all authors. Subsequently, the authors compared the identified tasks for the development of FCs and assigned them to the project management phases. Secondly, there is another challenge which has also been identified by Rehse et al. (2016) regarding the evaluation and changes of the model when new results appear. Because this study is based on existing case studies from research, new inputs can come up frequently. To include these in the model can be difficult because it is not easily expandable. The development of reference process models allows different visualization results. In our study, BPMNs as well as a checklist was developed. While BPMN is an established standard for process modelling, checklists are recognized by researchers as a rather new topic (Reijers et al. 2017). Checklists may be used instead of BPMNs or in combination (Baumann et al. 2017). Checklists have been successfully used in other domains like project management, where they are not standardized (Baumann et al. 2017) and mostly used for the organization of tasks in the team or as identifiers (Boehm 1991). So, as our study is based on project management phases, a checklist can be useful for our purpose. One major advantage of a checklist is its flexibility: We regard the application of checklists as very useful for the FC development because it enables a more flexible procedure as the "to do's" do not have to be in the order as they appear on the list and other activities can easily be complemented. BPMNs are more complex and difficult to understand. This was already observed by Baumann et al. (2017) who developed a rather complex type of checklist based on BPMNs and evaluated the checklist afterwards in comparison to the notation. Moreover, they found that people perceive checklists as easier to handle, more reliable, and believe that they give better orientation during projects. We also see the checklist as commonplace for most people and easier to understand than complex notations because the application of BPMNs is only possible with prior knowledge about processes and notations. The reduced complexity can also be observed by the space the checklists needs for presentation in this article compared to the BPMNs. In comparison the checklist is much shorter (Baumann et al. 2017). However, standard process notations like BPMN offer the advantage of being more structured and do not require a direct application (like tipping off tasks from the checklist) once the visualization is finished. It is also easier to visualize and understand parallel steps to present decisions and their different outcomes while checklist do not follow a clear sequential order (Baumann et al. 2017). The clear sequence of the tasks in the BPMNs is helpful as is gives better orientation throughout the process. Moreover, by being able to use different pools and lanes the stakeholders are better integrated in the model. It is possible for the viewer to see the interactions between the stakeholders at a glance. Our checklist focuses on the tasks of the teaching team only, so that the view

is more limited. Furthermore, because there is no standard checklist, the phenomenon of "checklist fatigue" is present. People are overburdened with completion of the lists (Hales et al. 2008). In sum, it can be concluded, that the decision for one of the two methods depends on the way the teaching team prefers to work and the environment of the FC. The best use situations for checklists are discussed diversely. As Stock and Sunder regard checklists as useful in situations without unexpected events (Stock and Sundt 2015), Baumann et al. (2017) see a strength by integrating modifications in the checklist but the underlying standard process needs to be consistent (Baumann et al. 2017). We also regard the checklist as more useful to changing environments than the BPMN because the effort to adapt the checklist is much lower. However, this might depend on the type of checklist in use. As checklists and BPMNs can complement each other and can compensate for their disadvantages, we decided to use both in our paper.

7 Conclusion and limitations

For the deduction of the reference process model we chose an inductive procedure to build upon existing FC cases from research. The structure of our model is in accordance with phases from project management. We aligned the activities to initialize and implement an FC class to four phases. The structure helps to remember all duties and can be used as a checklist (cf. fig. 8) (Rose 2013). The list is to be understood both as an overview and as a notepad so that all important activities are taken into account. Moreover, the process was modelled with the help of BPMN to get a more detailed visualization. The BPMNs, the checklist as well as the descriptions in chapter 4 give in sum in-depth information about the activities performed and the important milestones. Within the project initiation phase, both teaching team and administration decide about the introduction of an FC. During the planning phase, the rough and fine concept of the FC are developed. Besides the execution, the planning phase is the most demanding phase. In the execution phase the interaction with the students and the supply of online-material begins. When all in-class and out-of-class activities are finished, the evaluation phase starts. It is crucial to take into account how cost and time consuming the development and implementation of an FC is. The planning, content, conception and coordination between online and attendance phases as well as the intermediate examinations and quizzes require a high level of professional competence. This is why the training of the teachers is so important. Surprisingly, little is reported about this in the literature found. Regarding the results from our study, we acknowledge that FC is more for students than for pupils, as the learners need a self-paced learning experience. However, in general FC is not limited to any specified class of students (Rahman et al. 2014). Furthermore, there is a clear need for more conceptual models. Actual findings are dominated by anecdotal articles and presentations of cases (Lo and Hew 2017). Most articles imply somehow all phases but focus on different aspects. Future research could concentrate on single phases and the tasks or on single tasks covering all phases. Despite our merits, the research is not free of restrictions and limitations. Review articles built the dominating part of our literature base. We cannot rule out the possibility that there may be some articles dealing with a more specific issue that we have only been able to address in a marginal way. New articles could come with new aspects, which are not represented in the model so far. The visualization as checklist and BPMNs are influenced by the author's interpretation about the phases. Especially the order of tasks in the BPMN might be different in other cases. Moreover, the evaluation was done with one course in the working area of the authors. More evaluations in different environments might lead to new insights. We intend to interview FC teachers and students about our model and checklist in order to review our results and expand the model. A large and diverse set of data relating to the project management-centered

design of an FC could provide interesting information that would allow the model to be evaluated as well as benefits and barriers to be compared under different conditions and for different stakeholders. In summary, we believe that the application of our process model not only gives organizations and teachers a good overview of the tasks, processes and interrelationships for a flipped classroom implementation, but can also support them in setting up an effective project management as well as in assigning and carrying out individual tasks.

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