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. 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 develop a generic process model for the realization of flipped classroom concepts. The model is based on phases taken from project management, which help to structure the procedure and associated tasks.

Keywords: Flipped Classroom, Course Development, Project Management, Process Model, Checklist

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 primarily described by Bergmann and Sams in 2006 [1]. The number of publications as well as practical implementations are still increasing [2], [3]. A common understanding of the flipped classroom is that the activities of attendance time and time outside the classroom are switched [4]. Bishop and Verleger 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." [3] 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 [5], [6], 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 [3], [7-9].

Until now, only small parts of lectures are held as FC. One reason for this is a lack of knowledge about the design of these courses. Structural research providing an

14th International Conference on Wirtschaftsinformatik,
February 24-27, 2019, Siegen, Germany

overview of the topic is rare [10]. The dominating part of research available is case-based which leads to a "siloed" character of the research field, missing systematic approaches [2], [11]. This paper aims to present a 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 and use FC and are recommended to be used for implementation [3]. To proceed systematically, we align the necessary steps to project management phases. To identify tasks and challenges associated with each phase, we conduct a review of literature reviews about FC that is later enriched by a forward and backward search. Additional information on important to do's and possible questions are provided.

This paper contributes to research and practice by using a structural approach from another field of knowledge to systematize FC research. It also helps lecturers to design an FC. The focus 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. We conclude by summarizing and discussing the findings on the phases. Lastly, the limitations of our paper and an outlook for further research are shown.

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) [12]. Using this concept is unusual as several teaching designs and concepts already exist [13]. Teaching and traditional instructional designs (e.g., ADDIE [14]) include aspects of the competences, group of learners, and teaching subjects [13]. However, their dominating parts focus on pedagogical issues rather than on processual aspects [15]. The process-oriented step by step guideline is (especially in the field of FC-Design) still underrepresented [10]. 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.

Figure 1. Project Management Phases

In general, different guidelines to define project phases exist and the number of phases varies [12]. 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 in from the outset when stakeholders can best be involved [12]. 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

[12]. Using a theoretical perspective, we define four key phases to develop, implement, proceed and evaluate an FC course (see figure 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 execution. In the second phase, the planning, required resources are identified and 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.

These phases are used to define activities for developing and implementing a flipped classroom. The activities are identified by conducting a literature search, that reflects the current knowledge base of FC [16]. To get the best possible overview, we decided to conduct a meta-review of existing literature reviews. The findings of the individual reviews can be compared and contrasted [17]. The reviews are used to (1) give an overview of the field of FC research, (2) find activities for the FC development phases and (3) start a forward and backward search. The forward and backward search leads to FC case studies describing the performed activities. The process model is developed in iterative steps. In each step, the identified activities are collected, discussed and assigned to the phases. Figure 1 shows how the research methods and the structure of the paper are linked.

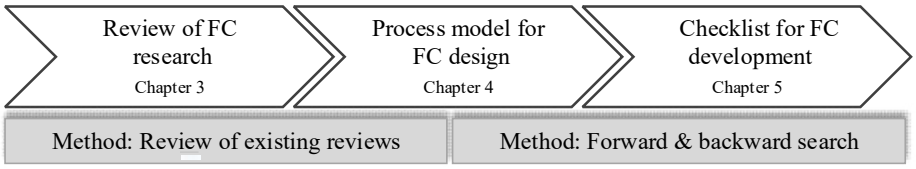

Figure 2. Research process

Our search was conducted in the following databases: Web of Science, Science Direct, Google Scholar, ERIC, AISNET and Scopus. We combined two research 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 [18], 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 21 articles, published between 2013 and 2018. 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 (see chapter 3). In a second step, we used the reviews to identify specific topics and tasks of the process of developing the FC. Articles, which showed evidence for at least one of the process’ phases, were analyzed in-depth. Consequently, we enriched the reviews by findings from further literature in the field of FC. To decide if the papers are useful for identifying tasks for the phases, we used the following selection criteria:

a) Tasks during FC implementation must be mentioned or at least described; b) Clear alignment to the process phases of the development, when tasks were performed; c) The case was assessed as a representative example (no unusual designs); d) The articles had a clear relationship to FC as a concept described by Bergmann and Sams in 2012 [1]; e) The results described a positive influence of the FC. We are referring to an FC term in a broader sense, as articles with additional traditional lecture content have also been included.

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, eight of them in 2018. Within our literature research, we identified 21 reviews in total. Six of them are meta-studies, e.g., [9], [7]. Eight reviews focus solely on teaching in health care, e.g., [6], [19] and three reviews examine FC courses in engineering [20–22]. 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 [23]. Regardless of the geographical location, several authors also observe a concentration of FC approaches on STEM (science, technology, engineering, math) and health students [2], [21], [9].

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 [24]. The attendance time is mainly used to apply that knowledge and to encourage group work and discussions [21]. 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” [25]. Within the FCs, it can be used to enhance the development of targeted learning materials, monitor the success of in-class activities [26] and enrich the final evaluation [27].

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 [7], [20], [28], [29]. Furthermore, better learning habits and positive attitudes are observed [21]. Nevertheless, some authors criticize the lack of control groups in many studies and state that the results of some studies are not statistically significant [6], [34]. Due to the different design possibilities of the FC courses, comparability is difficult. There are also a few results which state that student outcomes are not better in FCs compared to traditional methods [6]. Accordingly, new approaches for the evaluation of FC courses which unequivocally prove the success of FC are needed [5], [19]. Moreover, the high initial

costs and set-up times incurred when implementing an FC course, especially for the lecturers, are not yet sufficiently investigated [21], [30].

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 [2], [11].

4 Process Model for the Design of a Flipped Classroom

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

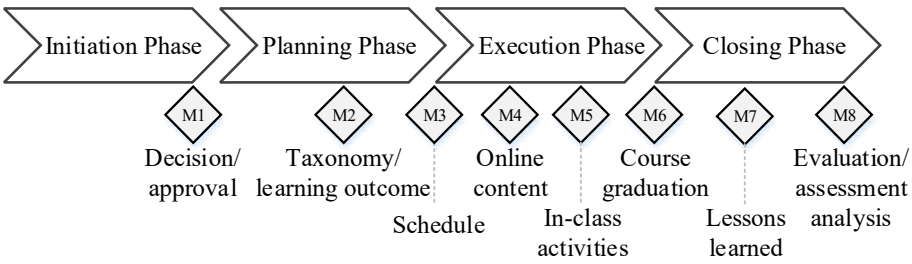

Figure 3. Milestones

4.1 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. Reasons for the redesign or creation 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 FC method can, for example, increase the student's motivation, performance, attendance and interaction during face-to-face sessions [20], [31]. It is useful to log the goals of the reorganization for the later evaluation. Once the goals which should be achieved by the FC have been determined, the time, staff and financial expenses of the implementation can roughly be estimated [12]. It should be checked whether necessary resources for a project team are available and to what extent costs for new acquisitions (e.g., learning management systems (LMS), video equipment) will be incurred [21], [30]. The affected stakeholders, as well as their benefits, challenges and barriers [12], must be identified. The stakeholders are the lecturers, 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 [30], [32].

Implementing the FC requires much effort, especially at the beginning, as the entire course has to be arranged in the FC format [21], [33]. Moreover, technical obstacles like cutting and uploading videos or the provision of self-learning tests on online platforms must be overcome [30]. Students can be actively involved in the redesign of the course by incorporating their feedback and ideas. However, according to Bishop, not all students are very fond of FC [3]. 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 prepare the classes. This requires the implementation of appropriate structures. The gamification approach can be beneficial if it corresponds to the motivational structures and preferences of the students [34]. Short quiz questions to enter the next content or competitions between students can be useful to make self-study of class content easier and more appealing. [30], [38]. Here too, technical and skill related hurdles must be overcome as soon as possible [32]. Apart from teachers and students, stakeholders within the organization may also be addressed, such as administrative staff or IT support [35]. 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. During the initiation phase, a decision should also be made as to whether Learning Analytics is 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.

At the end of the initiation phase, it has to be pondered whether the benefits of FC merit the time and financial investments. If so, the phase ends with the milestone *decision (M1)* to implement an FC course.

4.2 Planning Phase

When the decision is made to implement the FC, the second phase begins. The goal 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 [30], [36]. Thoughtful planning is essential [11] for the success of the FC. The conception of the FC requires several resources [36], in addition to the pedagogical organization of the course, the instructor needs support to create virtual content and quiz questions. A FC can be conducted without supporting structures within the school. It is advantageous for the planning and implementation of a FC to build a team of people in order to share tasks and exchange experiences as well as results. For the training of the teachers, there is only limited structured information available about the pre-learning activities and duties [36]. Balan recommends the introduction of learner groups to provoke higher student motivation and to focus on individual learning motivation and outcome reviews [37].

Teachers need to get and give information before the execution about needed adjustments in curricula as the course (format) could also impact these [38]. 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 lecturer wants to achieve within the course. Learning *taxonomies (M2)* are useful to structure the goals of the course [29], [39] 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 [39]. There are different designs that represent a full flip or partial flip [3]. Furthermore, they reflect the different learning levels [40]. As the online-videos often cover basic contents, the in-class courses can be used for application, discussion, problem-solving and collaborative learning [41]. In this context, it is important to identify the group of students who will be taught. Teachers can develop FC classes for pupils, undergraduates [41], higher education students [11], and specific professional groups [8] from different disciplines.

Furthermore, different learning types need to be considered [3]. The development of the FC can be improved if the lecturer is aware of the diversity of the class. Gender differences can affect students` perceptions and learning outcomes [42]. To convince students of the new method, the concept of FC should be explained beforehand, including the content, goals and the procedure [30]. For the quality of the learning, the design of in-class and out-of-class activities is very important [22], [32]. Pre-class online lectures are of great value if they provide students with the basic knowledge to proceed with interesting in-class actions [36]. For the time out of class mostly prerecorded video lectures, podcasts or screencasts are used [3], [22], [43]. Herreid et al. 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 programs like Camtasia or apps like Educreation [44]. As students can get easily distracted [45], it is recommended to use videos with a length of ten to 20 minutes [22]. The materials for the videos (e.g., slides) need to be planned beforehand [11] and produced step by step [46] before providing them to the students. For this purpose, subject areas have to be divided into several online contents [47]. The development of online courses is time-consuming. Researchers calculate the expenditure with approx. 1-2 hours per unit [33] and altogether 100 hours per course [48], whereby there is also the possibility of using already existing lectures [48]. The videos can be posted on platforms like YouTube, iTunes U, or on LMS like Blackboard and Moodle [44]. Lecturers should stay in contact with the IT support [30], [35] to guarantee easy access for the students [49]. It has proved to be beneficial to use existing technologies rather than developing new ones [50], [51]. As questions cannot be asked immediately [52] forums can enable discussions on the video content [53]. Regular quizzes that mirror the video content help to reduce distraction and ease the preparation for in-class activities [22], [45]. Out-of-class activities can be complemented by homework, pre-readings, automated tutoring systems or supplemental videos [11], [43]. Besides the planning of online lectures, lecturers need to decide which methods should be used in-class and prepare materials if needed. The pre-class preparation of an FC is much more time-consuming and complex than in traditional courses.

If the lecturer wants to use Learning Analytics to monitor student's activities, it has to be decided which data should be analyzed (e.g., trace data of the LMS like activation of course videos or solved online assessments), how the data is analyzed and how the

results used [26]. 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)* is finished so that the course has a general structure.

4.3 Execution Phase

The actions proceeded during the term are subsumed within the execution phase. 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 lecturer. This means the rules of the FC must be communicated beforehand [37], as students are less satisfied with unclear instructions and unknown situations [2]. The FC success depends mainly on the student's compliance [1], [30].

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) [3], [11], [43]. The activities chosen are very important as they differ in their effectiveness and conditions needed [43]. 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 [54], the attendance time needs to be planned more carefully for larger groups, for example by forming smaller groups and/or using peer-learning [55], [56]. Attendance time activities are often accompanied by smartphone apps, pair-and-share activities or clicker assessments for immediate feedback to bridge expectations [37], misunderstandings and knowledge gaps [11]. Furthermore, accompanying in-class assessments make it possible to test previous knowledge and ensure quality [51]. Mid-term assessments are a common technique to evaluate learning success [22]. In-class and online-assessments, complement the flip model [51]. Therefore, clear accordance of video tutorials and in-class content (and assessments) is essential [2], [57]. Furthermore, the total student-workload should be considered [58]. The teacher must permanently control and steer the course regarding the students' needs, the planned results and the amount of work.

The kind and tone of interaction are important for the satisfaction emphasized by the learners [50]. The original FC model was designed as a flipped mastery model with little peer interaction and a focus on individual learning [59]. The role of the teacher changes in an FC environment [1], [45]. Recently, the share of team-based learnings and high group interaction increased [37], [59]. 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 [37] [59]. These iterations seem quite time-consuming to the students and can lead to a resistance to change [37]. 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 [60].

In many studies learning success is directly linked to the exams. An FC design does not inevitably lead to a change in the way exams were carried out [61], but the high interaction and the available technical infrastructure enable changes [22]. Exams focused on problem-solving [62] or including bonus points [58] occur. In many cases exams mark the reaching of this milestone. The execution phase ends with *the graduation of the course (M6)*. This milestone marks the end of the interaction between the teacher and the students.

4.4 Closing Phase

The final phase of the FC process model is the closing phase. This is the time 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 analysis is based on the teacher's experience, exam results and measurements of the students' attitude towards the concept [58]. Therefore, differentiation between summative (to measure the outcome) and formative (to formulate the lessons learned and re-design the concept) evaluations is necessary [39].

Most evaluations in FC research are based on self-reported scales using quantitative and qualitative data [22]. These scales often comprise perceptions of feelings, subjective experiences and satisfaction [60]. To assess the attitude towards the FC even scales, close to self-efficacy rate, are taken. We identified scales measuring enjoyment, self-confidence and perceived value of the content [60]. Furthermore, the evaluation of the learning success [11] and the students' effectiveness are important [31]. Many researchers claim the increase of the learning success using an FC scenario [41]. Often the students' performance as a whole increase in FC classes compared to traditional lectures [63]. Kerr mentions that even the middle and the lower third of the examination group increase their performance [20]. These results mainly aim at the exam-outcomes. Further positive statements regarding the problem-solving ability of students exist [7]. Only a few studies show opposite results [30]. Despite the measurable learning success, Foldnes [59] 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 [26]. Only a few articles can be found that give room for the *lessons learned (M7)* to develop a sustainable culture of FC classes [9]. Teachers should use the closing phase to reconsider the contents and continuously work on the renewal of the contents and methods [11]. The pre-recorded online material should be critically revised [11]. In FC proceeding, 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 [9], [30]. 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.

5 Discussion and Conclusion

For the deduction of the conceptual process model we chose a project management model based on four phases. We aligned the activities to initialize and implement an FC class. The structure helps to remember all duties and can be used as a checklist (see Figure 4) [12]. Figure 3, combined with the following chapters and the checklist, will give in-depth information about the activities performed, the important milestones and detailed description including further text references for a clear understanding of how to design and run an FC. Within the project initiation phase, both lecturer and institution 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. The activities, already described in more detail in chapter 4, are summarized in a checklist in Figure 4. The list is to be understood both as an overview and as a notepad so that all important activities are taken into account.

It is crucial to take enough time to set up an FC. 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. Furthermore, there is a clear need for more conceptual models. Actual findings are dominated by anecdotal articles and presentations of cases [30]. 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. Also, our model has to be evaluated. 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, FC is not limited to any specified class of students [7].

For the evaluation of the model we plan to set up an FC for students based on the process model in order to gain further insights from our experience with the application of the model and to further concretize the individual steps. Also, 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 gains and barriers to be compared under different conditions and for different stakeholders.

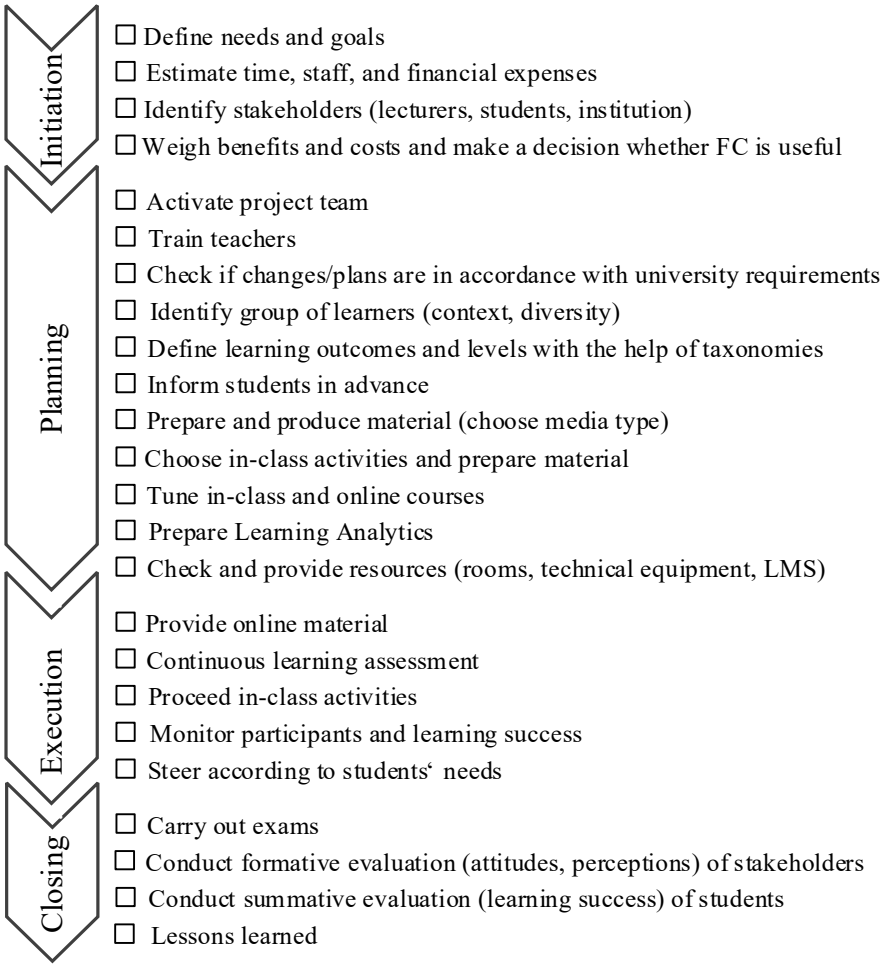

Figure 4. Checklist: Development of an FC

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