Applying a learning design methodology in the flipped classroom approach

– empowering teachers to reflect and design for learning

Evangelia Triantafyllou

Postdoc

Department of Architecture Design and Media Technology, Aalborg University Copenhagen

Lise Busk Kofoed

Professor

Department of Architecture Design and Media Technology, Aalborg University Copenhagen

Hendrik Purwins

Assistant Professor

Department of Architecture Design and Media Technology, Aalborg University Copenhagen

2

Olga Timcenko

Associate Professor

Department of Architecture Design and Media
Technology, Aalborg University Copenhagen

Abstract

One of the recent developments in teaching that heavily relies on current technology is the "flipped classroom" approach. In a flipped classroom the traditional lecture and homework sessions are inverted. Students are provided with online material in order to gain necessary knowledge before class, while class time is devoted to clarifications and application of this knowledge. The hypothesis is that there could be deep and creative discussions when teacher and students physically meet. This paper discusses how the learning design methodology can be applied to represent, share and guide educators through flipped classroom designs. In order to discuss the opportunities arising by this approach, the different components of the Learning Design – Conceptual Map (LD-CM) are presented and examined in the context of the flipped classroom. It is shown that viewing the flipped classroom through the lens of learning design can promote the use of theories and methods to evaluate its effect on the achievement of learning objectives, and that it may draw attention to the employment of methods to gather learner responses. Moreover, a learning design approach can enforce the detailed description of activities, tools and resources used in specific flipped classroom models, and it can make educators more aware of the decisions that have to be taken and people who have to be involved when designing a flipped classroom. By using the LD-CM, this paper also draws attention to the importance of characteristics and values of different stakeholders (i.e. institutions, educators, learners, and external agents), which influence the design and success of flipped classrooms. Moreover, it looks at the teaching cycle from a flipped instruction model perspective and adjusts it to cater for the reflection loops educators are involved when designing, implementing and re-designing a flipped classroom. Finally, it highlights the effect of learning design on the guidance, representation and sharing of flipped designs and how such an effect can move forward research on the flipped classroom.

Dansk resumé

En af de seneste udviklinger indenfor undervisning, der samtidig er stærkt afhængig af den nuværende teknologi, er brug af metoden: "flipped classroom". I "flipped classroom" er den traditionelle forelæsning og hjemmearbejde byttet om. Studerende modtager materiale til forberedelse/hjemmearbejde online, så de kan få den nødvendige viden inden forelæsningen, mens forelæsningstiden er afsat til præciseringer og anvendelse af denne viden. Hypotesen er, at der skal være mere tilbundsgående og kreative diskussioner, når lærer og studerende mødes fysisk. Denne artikel diskuterer, hvordan lærings design metoden kan anvendes til at præsentere, dele og lede undervisere gennem "flipped classroom" design. For at diskutere de muligheder, der er ved denne tilgang, er de forskellige dele af Learning Design – Conceptual Map (LD -

CM) præsenteret og behandlet i forbindelse med "flipped classroom". Artiklen viser, at brug af lærings design anvendt på "flipped classroom" kan fremme brugen af teorier og metoder til at vurdere dets indvirkning på opfyldelsen af læringsmål, samt at det kan styrke opmærksomheden på fastlæggelse af metoder til at sammenholde og evaluere elevernes svar. Desuden kan en læring design tilgang styrke den detaljerede beskrivelse af aktiviteter, værktøjer og ressourcer, der anvendes i bestemte modeller af "flipped classroom", og det kan gøre undervisere mere opmærksomme på de beslutninger, der skal træffes, samt hvilke mennesker, der skal inddrages ved udformningen af " flipped classroom". Ved at bruge LD - CM conceptet, henleder denne artikel også opmærksomheden på betydningen af de forskellige aktørers karakteristika og værdier, som kan have indflydelse på udformningen og succes af "flipped classroom" (for eksempel institutioner, undervisere, studerende, eksterne parter). Desuden ser artiklen på undervisningens cyklus fra et "flipped classroom" perspektiv så undervisningen tilpasses så den tager højde for de reflexions sløjfer som de involverede pædagoger har gjort, når de designer, gennemfører eller re- designer et "flipped classroom". Endelig fremhæves effekten af lærings design gennem vejledning, præsentation, diskussion og deling af "flipped classroom" design, samt hvordan dette kan støtte og bidrage til videre forskning om "flipped classroom".

Introduction

One of the recent developments in teaching that heavily relies on current technology and endeavours to make students owners of their learning trajectories is the "flipped classroom" approach (Hachmann & Holmboe, 2014). Lage et al. gave the following definition for this instruction model: "Inverting the classroom means that events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa" (Lage, Platt, & Treglia, 2000). Bishop and Verleger found this definition very broad and noted that it implies that the flipped classroom only represents a re-ordering of in-class and out-of-classroom activities. Therefore, they defined 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" (Bishop & Verleger, 2013). In this paper, we use the term "flipped classroom", as defined by Bishop and Verleger. In the section "Context", we provide more information about our own implementation of this instructional model.

Several studies on flipped classroom are showing very positive results but there has been some problems related to the use of different technologies as well as to new pedagogical challenges for the educators (O'Flaherty & Phillips, 2015). Therefore, theoretical as well as practical based guidelines for flipped classroom are very much needed (Abeysekera & Dawson, 2015). On the basis of our flipped classroom experience, we will discuss in this paper how the

learning design methodology can be applied to represent, share and guide educators through flipped classroom designs. In order to discuss the opportunities arising by this approach, the different components of the Learning Design – Conceptual Map (LD-CM) are presented and examined in the context of the flipped classroom. We find that viewing the flipped classroom through the lens of learning design can promote the use of theories and methods to evaluate its effect on the achievement of learning objectives, and that it may also draw attention to the employment of methods to gather learner responses. We use the learning design approach to show possibilities, which can enforce a detailed description of activities, tools and resources used in specific flipped classroom models. Moreover, the learning design approach can make educators more aware of the decisions that have to be taken and the people who have to be involved when designing a flipped classroom. By using the LD-CM in this article, we draw attention to the importance of characteristics and values of different stakeholders (i.e. institutions, educators, learners, and external agents), which influence the design and success of flipped classrooms. Moreover, we discuss the different theoretical aspects connected to teaching and learning when applying the LD- CM to the flipped classroom concept.   Finally, we discuss how the flipped classroom model can promote active learning and a new role for facilitators of the learning process.

The flipped classroom

In a flipped classroom the traditional lecture and homework sessions are inverted. Students are provided with online material in order to gain necessary knowledge before class, while class time is devoted to clarifications and application of this knowledge. Figure 1 shows the flipped classroom framework.
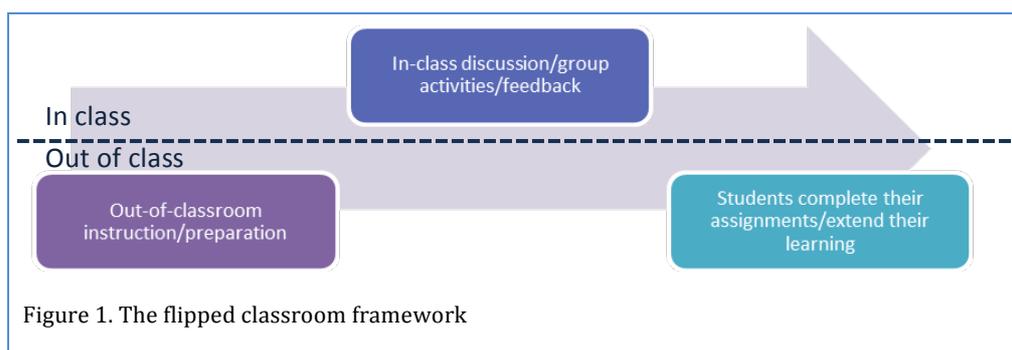

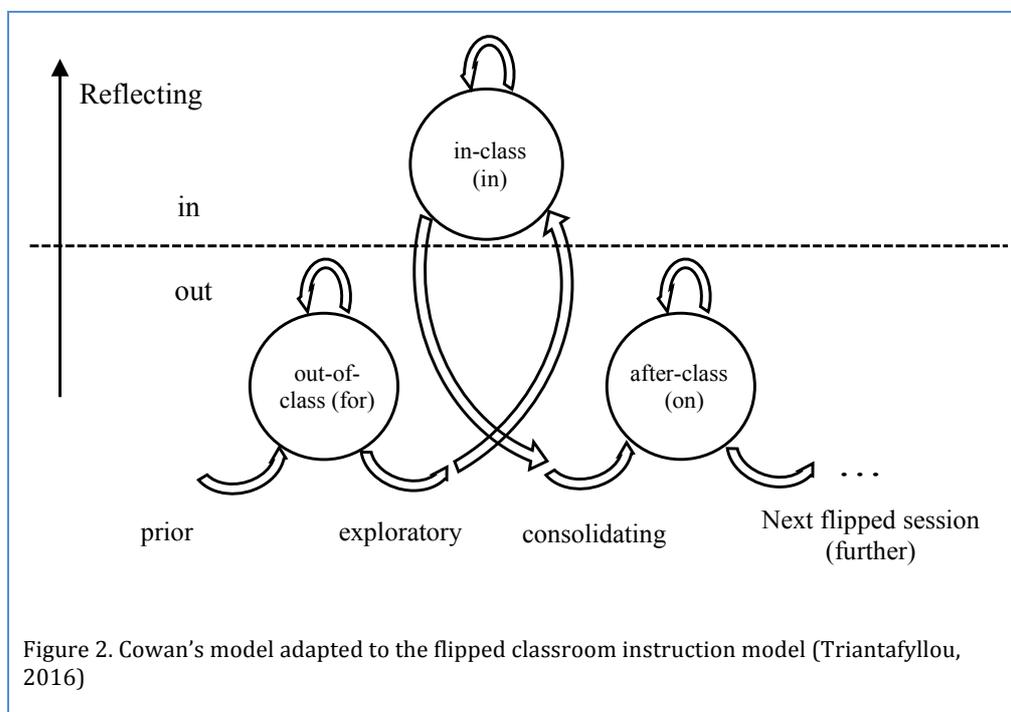Figure 1. The flipped classroom framework

The course content, which is provided for self-study, may be delivered in the form of video casts and/or pre-class reading and exercises, while class time is mainly used for group work activities (Berrett, Mangan, Neshyba, Talbert, & Young, 2015). The hypothesis is that there could be deep and creative discussions when the teacher and students physically meet.   Moreover, this teaching and learning approach endeavours to make students owners of their learning trajectories, and relies heavily on current technology.

There have been various attempts to apply the flipped classroom in educational environments. For example, Love and Hodge compared a classroom using the traditional lecture format with a flipped classroom during an applied linear algebra course (Love, Hodge, Grandgenett, & Swift, 2014). Students in the flipped classroom environment had a significant increase between the sequential exams compared to the students in the traditional lecture section, but they performed similarly in the final exam. Moreover, the flipped classroom students were very positive about their experience in the course, and particularly appreciated the student collaboration and instructional video components. Strayer compared a flipped statistics class with a traditional one (Strayer, 2012). He found that although students in the flipped classroom were less satisfied with classroom structure, they became more open to cooperative learning and innovative teaching methods.

However, there are also critics to this approach (Kellinger, 2012; Nielsen, 2012). Concerns include among others: criticism about the accessibility to online instructional resources, the growing move towards no homework, increased time requirements without improved pedagogy, teachers concerns that their role will be diminished, lack of accountability for students to complete the out-of-class instruction, poor quality video production, and inability to monitor comprehension and provide just-in-time information when needed. As a response to such concerns, researchers have proposed hybrid models of the flipped classroom. For example, the in-flipped classroom is designed to be a learning environment that consists of real and virtual teachers in the same classroom (Chiang & Wang, 2015), while the holistic flipped classroom has teachers offering synchronous support to students both in and out of the classroom (Chen & Chen, 2014).

Besides critics, other researchers noted that more research is needed on the flipped classroom in order to develop its theoretical foundation and design guidelines for such learning environments (Abeysekera & Dawson, 2015; O'Flaherty & Phillips, 2015). During our research on the flipped instructional model at the Media Technology Department, we proposed the use of Cowan's model of reflection for designing learning activities in flipped classrooms that involve students in reflection loops (Cowan, 1998). Figure 2 presents the adaptation of Cowan's model to the flipped classroom instruction model (Triantafyllou, 2016). The dashed line separates the reflection loops taking place outside the classroom from those taking place in the classroom. Cowan combined the analytical reflection from Kolb's experienced-based learning cycle "experience-reflect-generalize-test" (Kolb, 1984), with Schön's evaluative reflection for creating this model of reflection loops (Schön, 1983). Schön's reflection-for-action is the reflection that takes place prior to actions, while his reflection-in-action and the actual action take place at the same time. Kolb's reflection-on-action is more systematic than reflection-in-action and a means to get from

experience to conceptualization. We argued therefore that when out-of-class and in-class activities are designed properly and the reflection process is facilitated by the teacher, the flipped instruction model with its out-of-class, in-class and after-class phases can be utilized to progress experienced-based learning.

Figure 2. Cowan's model adapted to the flipped classroom instruction model (Triantafyllou, 2016)

However, this model of reflection focuses only on a specific part of a flipped classroom (how to design learning activities) and only on student learning in such classrooms. Our experience has shown that participating in the re-design of courses according to the flipped classroom approach is also a learning and reflection process for educators (Timcenko, Purwins, Triantafyllou, & Kofoed, 2015). Therefore, we discuss in this paper how this reflection model can be combined with a learning design methodology in order to support a holistic design and the reuse of flipped classrooms, while at the same time providing a framework for promoting and observing teacher reflection and development (Conole & Weller, 2008). The next section discusses the learning design methodology and explains how it can be applied in a flipped classroom context.

Applying the learning design conceptual map to the flipped classroom approach

Learning design refers to the process of creating new practices, learning activities, tools and resources in order to obtain specific learning objectives in a given context (Mor, Craft, & Maina, 2015). Koper (2006) provides the following definition for learning design:

> "A 'learning design' is defined as the description of the teaching-learning process that takes place in a unit of learning (e.g., a course, a lesson or any other designed learning event). The key principle in learning design is that it represents the learning activities and the support activities that are performed by different persons (learners, teachers) in the context of a unit of learning"
>
> (Koper, 2006)

Other researchers have replaced the term learning design with the term design for learning in order to emphasize the fact that learning cannot be designed, but instead designs can be produced to promote learning (Goodyear & Dimitriadis, 2013).

Conole & Weller (2008) mentioned the following advantages of adopting a learning design approach:

> "1. It can act as a means of eliciting designs from academics in a format that can be tested and reviewed with developers, i.e. a common vocabulary and understanding of learning activities.
> 2. It provides a means by which designs can be reused, as opposed to just sharing content.
> 3. It can guide individuals through the process of creating new learning activities.
> 4. It creates an audit trail of academic design decisions.
> 5. It can highlight policy implications for staff development, resource allocation, quality, etc.
> 6. It aids learners in complex activities by guiding them through the activity sequence."
>
> (Conole & Weller, 2008)

Learning design can be applied at different levels of educational practice, e.g. lesson, course or even curriculum level (Dalziel, 2013). Moreover, it may be motivated by different pedagogical theories and employ different (technological) tools and resources. In order to conceptually define learning design as a unified framework for teacher-led design of teaching and learning activities, a team of experts compiled The Larnaca Declaration on Learning Design (Dalziel et al., 2013) during a meeting held in Larnaca, Cyprus in September 2012. The Larnaca Declaration combined the core concepts of Learning Design (guidance, representation, sharing) with the broader education landscape. Figure 3 presents the Learning Design Conceptual Map (LD-CM) from the Larnaca Declaration, which illustrates connections between teacher planning activities (above), core learning design concepts (middle) and implementation activities (below) (Dalziel,

2015). In this conceptual map, boxes are called "components" and items within a box are called "elements".
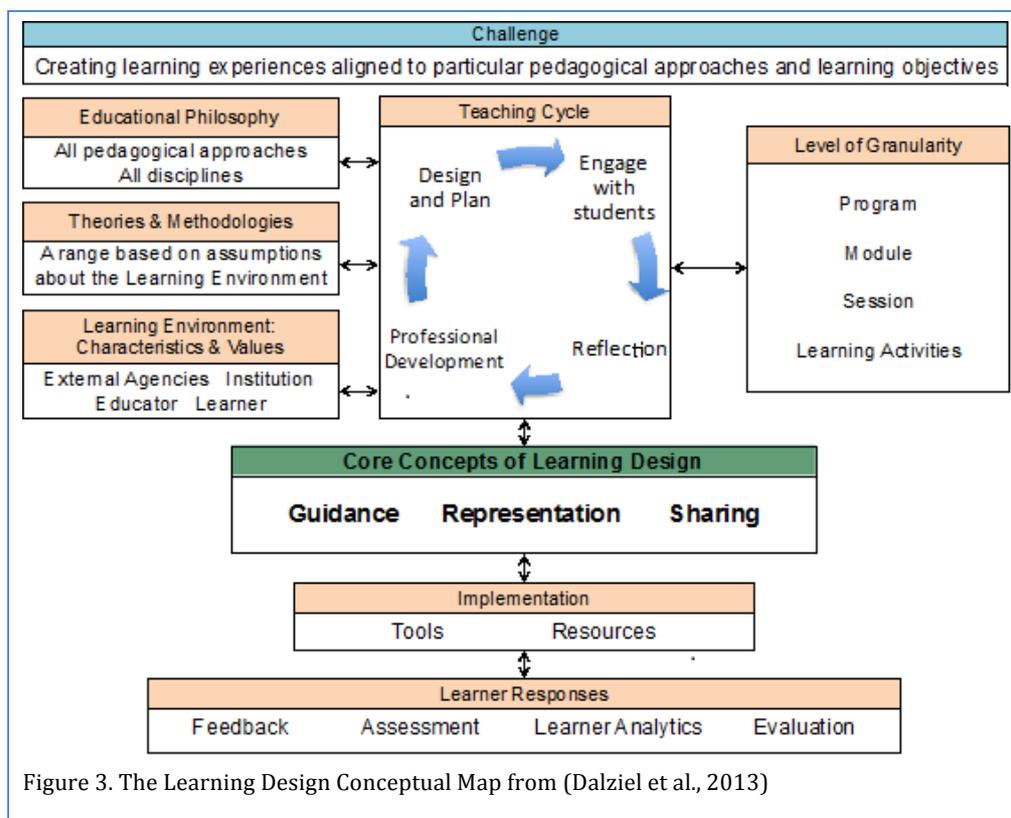

Figure 3. The Learning Design Conceptual Map from (Dalziel et al., 2013)

In this article, we argue that the use of this conceptual map for the representation and dissemination of different flipped classrooms designs can also contribute to the development of design principles in this field, because it provides a common foundation and a guide when one decides to apply this instructional model. In this case, the model will be instantiated with the component of the educational philosophy containing the pedagogical approach guiding the flipped classroom adoption (e.g. active learning, Problem-Based learning, etc), the component of Theories & Methodologies (III.2) containing the specifics of the learning environment based on the flipped classroom framework. The component of the Learning Environment will be defined by the local context (institution, educator, etc).

In the following, we go through all components of the LD-CM and we explore how they can contribute to represent flipped classroom designs.

Challenge

The Larnaca Declaration defines challenge as "creating learning experiences aligned to particular pedagogical values and objectives". This is a general educational challenge, in order to cater for different pedagogical approaches and contexts. The actual pedagogical approaches and learning objectives will be determined by the given educational context, i.e. the Learning

Environment, external agencies and educators, and the chosen Educational Philosophy, Theories and Methodology. In the case of the flipped classroom, this local educational context affects the design and implementation of flipped classrooms, e.g. the pedagogical approach that underpins the use of this approach, institutional rules affecting implementation issues and assessment, etc. However, we believe that the reflection model that we proposed for designing student experiences in flipped classrooms (Figure 2) belongs to this component, since it can be applied to every flipped classroom design and implementation. We perceive this model as a guide in order for educators to design experiences that involve students in reflection loops and progress experienced-based learning irrespective of the local educational context. Therefore, this component of the LD-CM provides a structure for analysing the educational context and how this context together with the proposed reflection model impacts the teaching and learning activities.

Educational Philosophy

This component of the LD-CM refers to the pedagogical theories that underlie decisions about teaching and learning. Such theories are most often dictated by educators, but other factors, such as educational institutions and government education departments, can also affect educational philosophy. This component also notes that the methodology of learning design can be applied to all discipline areas.

In the literature, there have been used various pedagogical theories to justify the flipped classroom and support the choices for teaching and learning (in- and out-of-class) activities (Bishop & Verleger, 2013). Such pedagogical theories typically argue for the benefits of student-centred and collaborative learning (e.g. active learning, Problem-Based Learning (PBL), peer-assisted learning, collaborative learning). When the LD-CM is used to describe a flipped classroom design, important decisions guided by this component and related to the structure of teaching and learning will follow the flipped classroom framework (in- and out-of-class sessions, teacher as facilitator sessions, etc). However, different educators will produce different flipped classroom designs and implementations by making choices based on the pedagogical theory they follow and their personal interests and values. Such choices may include different aspects, such as the format of out-of-classroom instruction material, the duration of out-of-class instruction, the type of classroom activities, the teacher's role in the class, how much of in-class sessions or of the course will be flipped, to name a few (Triantafyllou, 2015). The answers to such questions are taken in the Teaching Cycle component and are influenced by the Learning Environment component, but they are guided by theories of the Educational Philosophy component.

Theories and Methodologies

This component relates to theories and research methods used to guide decisions about learning design, as well as to evaluate the impact of those

decisions. Such theories may elaborate on the relationship between cognition and experience, on the forms of interaction between people, on motivation, etc. The research methods are used to provide evidence for educational effectiveness and may include quantitative and qualitative methods, experimental control studies, case studies, etc. This component is also influenced by the characteristics and values of the learning environment, e.g. what is considered to be a (positive or negative) impact, what kind of research methods are permitted, etc.

With regard to research on the flipped classroom, there is a lack both in theories and in controlled studies that quantitatively examine the achievement of learning objectives throughout a semester (Bishop & Verleger, 2013). We suggest that the use of a learning design methodology can make researchers aware of this lack and contribute to them leveraging existing theories to guide their decisions and employing more elaborated methods (e.g. quantitative and long-term studies) for evaluating the effect of flipped classrooms.

Learning Environment: Characteristics and Values

This component of the LD-CM may be employed to describe how the learning context influences the design of teaching and learning activities. To this end, both the characteristics and values of external agencies, institutions, educators and learners are relevant to understanding an educational context. As we mentioned before, there are several design considerations when introducing a flipped classroom, which are affected by the learning environment. For example, educational institutions usually have formal rules on student assessment and course content, which a flipped classroom cannot deviate from. Moreover, institutional characteristics define the physical and virtual environments that are available for flipped classrooms. External agencies (e.g. government, industry, etc.) may also influence how much freedom educators have in their teaching and the setting of specific learning objectives.

As far as values are concerned, educators bring different characteristics and values to their decision-making about teaching and learning activities. Such values include previous experiences as teacher and learner, experience in classroom/online teaching, perceptions of the kind of learning that is important, etc. Since the flipped classroom framework is a generic one, such values will influence the actual design and implementation of a flipped classroom. Moreover, learner characteristics and values have also an influence in learning design. For example, factors such as responses to teaching and learning activities, previous learning experiences, the level of motivation, and personal ambitions influence decisions on the selection of teaching and learning activities. In this component, different assumptions LD-CM will have different impacts on how teaching and learning activities are planned and delivered in a flipped classroom, and how learners respond to these activities.

Teaching Cycle

This component of the LD-CM is related to the Teaching Cycle and its impact on the design of teaching and learning activities. The LD-CM draws attention to how educators engage with learners, and how this interaction may affect their teaching "in the moment" to the changing dynamics of the classroom. The Teaching Cycle contains also the stage of reflection during and after teaching, which is also important to future design decisions. This process of reflection may have a long-term impact on educational practice and subsequent Teaching Cycles, which is captured in the "Professional Development" element.

In the flipped classroom, educators have to reflect on their own teaching even before the event of teaching since the design of a flipped classroom requires careful consideration of the course structure and content. First of all, the educator has to decide which parts of the course and what kind of activities are suitable for out-of-class instruction and which are suitable for classroom sessions. In many cases, educators have to come up with new activities or design the whole course in order to adjust it to the flipped classroom model. This new role for educators in the flipped classroom is well-aligned with the learning design approach. Finally, the flipped classroom promotes active engagement with students, since most of the classroom time is devoted to activities where the teacher acts as facilitator.

Level of Granularity

This component of the LD-CM acknowledges that design of teaching and learning activities can happen on different levels of granularity, i.e. (individual) Learning Activities, Sessions, Modules (like courses), and Programs (e.g. a degree or a year of school education).

The flipped classroom framework spans up to the first three levels of this distinction, since typically it is applied for the redesign of courses (Modules). However, it can be also applied in lower levels of Granularity, e.g. an educator may select to flip only few of his lectures or a part of each lecture. The design of a flipped classroom requires decisions in all three levels, e.g. form of Individual Activities, learning objectives of out-of-class activities, structure of class sessions, etc. However, it does not involve decisions on the Program level, since it is applied to specific Modules.

Core Concepts

The core concepts of learning design are Guidance, Representation and Sharing. Guidance contains the different ways that educators can be assisted during their teaching and learning decision-making. An important aspect of Guidance is also the information accompanying shared learning design, in order to help other educators to adapt it to another context. Representation promotes the idea of a descriptive framework for representation and visualisation of teaching and learning activities. The Larnaca Declaration

acknowledges the fact that "…the field of learning design is yet to develop a widely accepted framework for representation of teaching and learning activities." (Dalziel et al., 2013). However, various projects have provided indications of how this framework might be conceptualised (Conole & Weller, 2008; Dalziel, 2013). The "Sharing" element highlights the propagation of good practices from one educator to another, which is also the aim behind Representation. Learning design aims at the creation of open repositories of different designs, which will contain enough information for educators to apply them in local contexts.

We argue that the core concepts of learning design can greatly benefit research in flipped classroom, since many studies in the field lack details on their design (e.g. type and content of activities, sequence of activities, tools and resources used (Bishop & Verleger, 2013)). This fact makes it difficult both to compare different studies but also to apply already tested designs to other contexts. Using a common framework for representation of flipped classroom designs, which will contain all the necessary information for local adaptation will move forward the field of flipped classroom and provide more insight on opportunities and challenges of this approach.

Implementation

This component of the LD-CM involves different Tools and Resources required during teaching. Such Tools and Resources include both physical tools and educational resources. In the context of the flipped classroom, teaching and learning activities may require tools such as discussion forums, quizzes, surveys etc., and resources such as videos lectures and websites. Since there are many different tools to support the flipped instruction model, describing the elements of this component in detail is a very important aspect of a flipped classroom design, in order for Guidance and Sharing of designs to be feasible.

Learner Responses

The component of "Learner Responses" captures different types of information on student learning, such as learning outcomes, competencies, skills and understanding. Learning design draws attention to other forms of response from learners apart from official Assessment. This component also encompasses Feedback, i.e. the real-time responses that may adjust teaching, the more structured Evaluation of teaching, such as course surveys, and Learning Analytics based on data made available by the representation and execution of learning designs.

In the context of flipped classrooms, all this kind of Learner Responses are relevant and can contribute to the improved designs of such classrooms. The element of Assessment is probably the first to be considered, since the new instruction model may have implications on student assessment. Feedback is also important, especially for out-of-classroom instruction.

In the following, we present the context of our research on the flipped classroom instruction model. Then we employ particular empirical considerations for the different components in the map in order to exemplify the use of this map in flipped classrooms.

Context of empirical considerations

The empirical considerations in this paper are based on three studies that we conducted during three semesters at Aalborg University Copenhagen. For these studies, we introduced the flipped instructional model during three consecutive semesters at the Media Technology department. In the first semester, we introduced a flipped classroom approach for a part of a statistics course (Triantafyllou & Timcenko, 2014), while in the second semester we used this approach for a workshop on mathematics related to computer graphics rendering (Triantafyllou & Timcenko, 2015). During the third semester, we applied the flipped classroom approach to a statistics course during a whole semester (Triantafyllou, Timcenko, & Busk Kofoed, 2015).

In the first and second semester, we conducted a survey study in order to further investigate student acceptance and experiences in the flipped model, and student perceptions and preferences on screencasts. These online surveys used a Likert scale in order to collect student responses. Items in the survey were measured using 5-point rating scales, with the range of answers from "strongly disagree" to "strongly agree." Moreover, there were items, which gave students the opportunity to provide further information in an open-ended manner. In the first semester, we collected answers from 104 fourth-semester students, while in the second semester 46 fifth-semester and master students responded to the survey. The results of these two survey studies and their analysis are described in (Triantafyllou & Timcenko, 2014) and (Triantafyllou & Timcenko, 2015) respectively.

In the third semester, we conducted two survey studies and two focus group interviews among fourth semester students. The first online survey was distributed after four classes using the flipped instruction model. The survey was designed to gather student perceptions on the out-of-classroom preparation. We collected responses from 80 students. The second online survey was distributed after seven flipped classrooms and used a Likert scale in order to collect student opinions on issues raised by their answers in the first survey. Items in this survey were measured using an 11-point rating scales, with the range of answers from 0 ("strongly disagree") to 10 ("strongly agree"). In the second survey, we collected responses from 47 students. Towards the end of the semester, we conducted two focus group interviews with 7 students who volunteered to participate. We performed these interviews because we wanted to get qualitative data in order to get a

deeper understanding on the questionnaire responses. The results obtained during the third semester and their analysis are described elsewhere (Triantafyllou et al., 2015).

Empirical considerations based on the components of the LD-CM

In this section, we provide some of our empirical considerations in the flipped classroom approach for each component in the LD-CM in order to exemplify the use of the learning design framework as a foundation for describing flipped classrooms.

Educational Philosophy

Our own flipped classroom design was guided by the PBL pedagogy, which Aalborg University applies since its establishment in 1974 (Barge, 2010). PBL is a student-centred instructional approach, in which learning begins with a problem to be solved (Hmelo-Silver, 2004). Students need to acquire new knowledge in order to solve the problem and therefore they learn both problem-solving skills and domain knowledge. In PBL, the teacher's role differs from the traditional role as instructor. The teacher in PBL is a facilitator of the learning process, who is there to guide the students and to help when needed without instructing them what to do. All these characteristics of PBL are aligned with the aim and structure of a flipped classroom and have affected our decision to integrate the flipped classroom in educational practice. Moreover, PBL has guided decisions regarding the content of activities and the materials used and also the setting for learning activities.

Theories and Methodologies

Throughout our research on the flipped classroom, we adopted a theoretical framework for empirical investigation on the potential of flipped classrooms to cater for motivation and better management of the cognitive load (Abeysekera & Dawson, 2015). Regarding research methods, we employed both quantitative and qualitative methods to evaluate the effect of our interventions to student motivation and student perceptions of the learning environment (see previous section). However, we were not able to draw firm conclusions in terms of improvements to student learning, as we did not measure this quantitatively.

Learning Environment: Characteristics and Values

In all our flipped classroom designs, the learning process generally followed the same sequence. Prior to class, students were expected to watch the related video lessons and read the external web resources. In the second and third semester, students were also provided with some practice problems/quizzes, which were related to the material they had just studied. In all cases, students were provided with a reading guide in order for students to not get lost in the provided information. During class, a

question round took place, in order to clarify aspects that students found challenging. Then, students were provided in-class assignments to reflect on, discuss, and practice what they had learned. The classroom activity was mainly not teacher led; instead, students in groups worked on the assignments while the instructor provided individual guidance as needed. The in-class activities were structured so as to provide students with a variation of the tasks they completed when watching the video, providing opportunity for both practice and transfer of learning to new situations. Additionally, some activities were teacher led demonstrations.

In our case, many of our decisions were driven by characteristics and values of the environment, the educators, and the learners. For example, we knew that our students are used to work in groups and therefore chose to introduce only group activities in classroom. However, we have not documented and probably were not fully aware of which of these factors have influenced our design and to what extent. To our point of view, this is a very important dimension in the flipped classroom research, which literature has yet to clearly discuss.

Teaching Cycle

Our experience showed that the flipped classroom design and implementation forced educators to reflect on their own practice, and reconsider the learning objectives of specific activities and the course in general (Timcenko et al., 2015). Another aspect that promotes teacher reflection is the production of video lectures. Educators reported that they got valuable feedback on their own style of teaching, which they were able to improve during the loop video capture – watching – improving – recapture. Moreover, our experiences showed also that educators got insight on student problems and misconceptions. Finally, educators reflected on each flipped session (out-of-class, in-class) and they adjusted the next one throughout the semester, and after the end of the semester they reflected on this experience as a whole. These reflections promoted the redesign of their flipped classroom approach for the next year.

The aforementioned considerations led us to conclude that the flipped classroom approach can convert teaching experience to professional development by involving educators in reflection loops in the same way it promotes student learning. Therefore, we propose that the Teaching Cycle in flipped classrooms can be adjusted to fit Cowan's reflection loops model (Figure 4). In this Teaching Cycle, reflection is not a separate stage in the Cycle but it is present in all stages of the Cycle like a vertical dimension (before (reflection for), during (reflection in), and after (reflection on)). The Professional Development stage becomes the horizontal dimension, which evolves together with the reflection loops. This Teaching Cycle can be seen in a micro-level, taking place after each flipped session and a macro-level, taking place after the design and implementation of a flipped course/module etc.
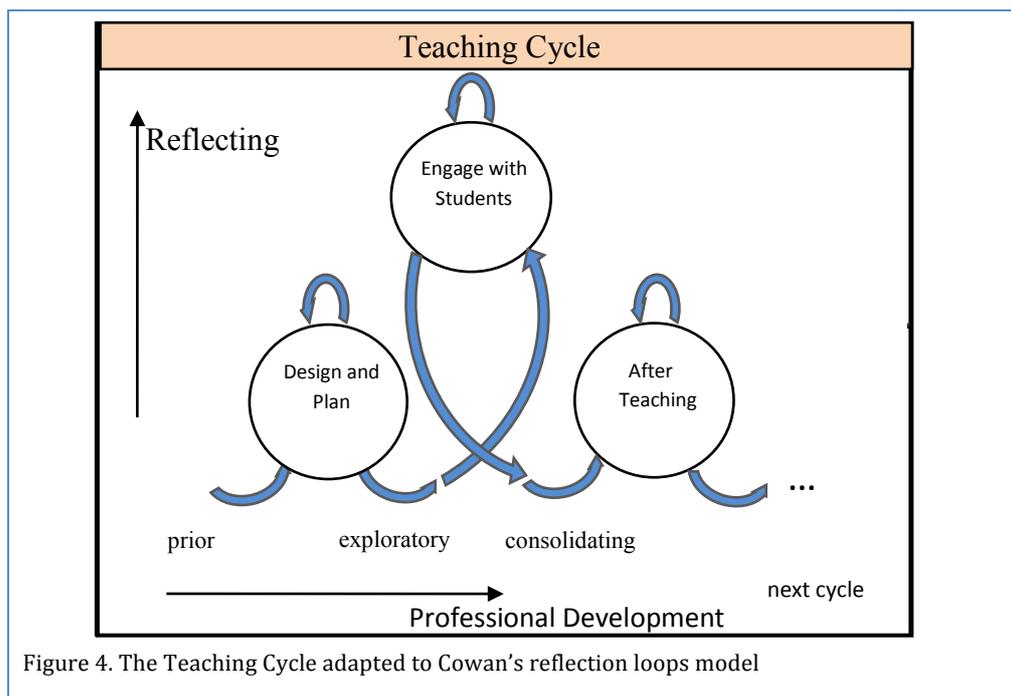
Figure 4. The Teaching Cycle adapted to Cowan's reflection loops model

Level of Granularity

Our design and implementation of the flipped model has been applied both on Session and Module level (Triantafyllou et al., 2015; Triantafyllou & Timcenko, 2014). This distinction may be straightforward, but we believe that it can make evident what kind of decisions have to be taken at each level and which parts have to be involved.

Implementation

To facilitate the flipped classroom instructional approach, we provided students with online resources for out of classroom instruction. Our flipped classroom design was facilitated by the Moodle VLE. For more information on the implementation in Moodle, the reader is referred to (Triantafyllou, 2015).

In the first semester, we created our own screencasts (recordings of the computer screen output, while the teacher solves an exercise). These screencasts were combined with selected sections of the www.mathisfun.com webpage, readings from the www.betterexplained.com webpage, and scanned lecture notes from their past mathematics course covering the relevant subjects. The online resources were chosen with the criterion to provide straightforward and intuitive explanations. In-class assignments were provided along with each lesson.

In the second semester, we substituted our screencasts with selected Khan Academy screencasts and related practice problems (https://www.khanacademy.org/), because our experience revealed that creating quality screencasts is time consuming and hard. Students were

required to choose at least one of the proposed resources for studying before lectures and then answer some short exercises. We estimated that going through any of the provided resources would not take more than one hour and a half to complete.

In the third semester, we created video recordings with the teachers of the course and a list with online resources about the topic of each class. Before classes, students had to study this material and also read suggested parts of the course book. Moreover, students had to submit their answers to multiple choice questions or to short exercises before attending each class. The questions and exercises covered the preparation material. We used these assignments in order to observe student understanding, misconceptions and common mistakes, and in order to motivate students to do their preparation.

During class sessions, group activities, feedback sessions and lecturing have been used for completing the learning process. Students were required to upload their in-class activities after class, in order for the teachers to check their progress.

Learner Responses

In our own design, we made diagnostic tests and in-class activities part of the Assessment and we provided students with the opportunity to send feedback to the teacher by using the "feedback" module in Moodle. The format of the final exam for the course was not changed, since it involved a small scale project. By using reports in Moodle, we were able to observe student activity and interaction with the provided resources.

Conclusion

This paper has discussed how the learning design methodology can be applied to represent, share and guide educators through flipped classroom designs. In order to discuss the opportunities arising by this approach, the different components of the LD-CM were presented and examined in the context of the flipped classroom. It has been shown that viewing the flipped classroom through the lens of learning design can promote the use of theories and methods to evaluate its effect on the achievement of learning objectives, and that it may draw attention to the employment of methods to gather learner responses. Moreover, a learning design approach can enforce the detailed description of activities, tools and resources used in specific flipped classroom models, and it can make educators more aware of the decisions that have to be taken and people who have to be involved when designing a flipped classroom. By using the LD-CM, we have also drawn attention to the importance of characteristics and values of different stakeholders (i.e. institutions, educators, learners, and external agents), which influence the design and success of flipped classrooms. Moreover, we have looked at the teaching cycle from a flipped instruction model

perspective and we have adjusted it to cater for the reflection loops
educators are involved when designing, implementing and re-designing a
flipped classroom. Finally, we have highlighted the effect of learning design
on the guidance, representation and sharing of flipped designs and how
such an effect can move forward research on the flipped classroom.

The flipped classroom model was introduced to promote active learning
and a new role for educators as facilitators of the learning process.
However, it is a generic model that leaves many issues to different
interpretations. By using a learning design methodology, educators can
create improved flipped classroom designs based on informed decisions,
and share these designs by other educators, who will adapt these designs
to local contexts, and potentially share back improved versions of the
original design. This can contribute to educators who create, share, and
adapt flipped classrooms while working together in communities of
practice.

References

Abeysekera, L., & Dawson, P. (2015). Motivation and cognitive load in the
flipped classroom: Definition, rationale and a call for research. *Higher
Education Research & Development, 34*(1), 1-14.
doi:10.1080/07294360.2014.934336

Barge, S. (2010). *Principles of problem and project learning, the aalborg PBL
model*. Aalborg: Aalborg University.
doi:http://www.aau.dk/digitalAssets/62/62747_pbl_aalborg_modellen.
pdf

Berrett, D., Mangan, K., Neshyba, S., Talbert, R., & Young, J., R. (2015, The
Chronicle of Higher Education). A guide to the flipped classroom,
http://images.results.chronicle.com/Web/TheChronicleofHigherEducat
ion/%7B422bb09a-27eb-42ba-ad69-a455e627572b%7D_AD-CHE-
FlippedClassroomBooklet.pdf.

Bishop, J. L., & Verleger, M. A. (2013). The flipped classroom: A survey of
the research. *ASEE National Conference Proceedings, Atlanta, GA,*

Chen, H. Y. L., & Chen, N. S. (2014). Design and evaluation of a flipped
course adopting the holistic flipped classroom approach. *Advanced
Learning Technologies (ICALT), 2014 IEEE 14th International Conference
On,* 627-631. doi:10.1109/ICALT.2014.183

Chiang, Y., & Wang, H. (2015). Effects of the in-flipped classroom on the
learning environment of database engineering. *International Journal of
Engineering Education, 31*(2), 454-460.

Conole, G., & Weller, M. (2008). Using learning design as a framework for
supporting the design and reuse of OER. *Journal of Interactive Media in
Education,* (1)

Cowan, J. (1998). *On becoming an innovative university teacher: Reflection in action* Society for Research into Higher education & Open University Press.

Dalziel, J. (2013). Implementing learning design: A decade of lessons learned. *Electric Dreams.Proceedings Ascilite*, 210-220.

Dalziel, J. (2015). Reflections on the art and science of learning design and the larnaca declaration. *The art & science of learning design* (pp. 3-14) Springer.

Dalziel, J., Conole, G., Wills, S., Walker, S., Bennett, S., Dobozy, E., . . . Bower, M. (2013). The Larnaca declaration on learning design - 2013. Retrieved from http://www.larnacadeclaration.org/

Goodyear, P., & Dimitriadis, Y. (2013). In medias res: Reframing design for learning. *Research in Learning Technology, 21*

Hachmann, R., & Holmboe, P. (2014). *Flipped learning - mere end bare video* (1st ed.) PRAXIS - Nyt Teknisk Forlag.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review, 16*(3), 235-266.

Kellinger, J. J. (2012). The flipside: Concerns about the "New literacies" paths educators might take. *The Educational Forum, , 76*(4) 524-536.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development* Englewood Cliffs, NJ: Prentice-Hall.

Koper, R. (2006). Current research in learning design. *Educational Technology & Society, 9*(1), 13-22.

Lage, M. J., Platt, G. J., & Treglia, M. (2000). Inverting the classroom: A gateway to creating an inclusive learning environment. *The Journal of Economic Education, 31*(1), 30-43. doi:10.2307/1183338

Love, B., Hodge, A., Grandgenett, N., & Swift, A. W. (2014). Student learning and perceptions in a flipped linear algebra course. *International Journal of Mathematical Education in Science and Technology, 45*(3), 317-324. doi:10.1080/0020739X.2013.822582

Mor, Y., Craft, B., & Maina, M. (2015). In Maina M., Craft B. and Mor Y. (Eds.), *The art & science of learning design*. Rotterdam, The Netherlands: Sense Publishers.

Nielsen, L. (2012). Five reasons I'm not flipping over the flipped classroom. *Technology & Learning, 32*, 10-46.

O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. *The Internet and Higher Education, 25*(0), 85-95. doi:http://dx.doi.org/10.1016/j.iheduc.2015.02.002

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action* Basic books.

Strayer, J. (2012). How learning in an inverted classroom influences cooperation, innovation and task orientation. *Learning Environments Research, 15*(2), 171-193. doi:10.1007/s10984-012-9108-4

Timcenko, O., Purwins, H., Triantafyllou, E., & Kofoed, L. B. (2015). Blended course with flipped classroom approach: Experiences. *The Sixth International Conference on E-Learning,* Belgrade, Serbia.

Triantafyllou, E. (2015). The flipped classroom: Design considerations and moodle. *Exploring Teaching for Active Learning in Engineering Education (ETALEE),* Copenhagen, Denmark.

Triantafyllou, E., & Timcenko, O. (2015). Student perceptions on learning with online resources in a flipped mathematics classroom. *Proceedings of the 9Th Congress of European Research in Mathematics Education (CERME9),*

Triantafyllou, E., Timcenko, O., & Busk Kofoed, L. (2015). Student behaviors and perceptions in a flipped classroom: A case in undergraduate mathematics. *Proceedings of the Annual Conference of the European Society for Engineering Education 2015 (SEFI 2015),* Orleans, France.

Triantafyllou, E., & Timcenko, O. (2014). Introducing a flipped classroom for a statistics course: A case study. *The EAEEIE (European Association for Education in Electrical and Information Engineering) 25th Annual Conference, (EAEEIE 2014),* 5-8. doi:10.1109/EAEEIE.2014.6879373

Triantafyllou, E. (2016). *ICT-based teaching methods for improving mathematics learning for media technology students: Investigation and findings.* Aalborg Universitetsforlag.