

# Towards a MOOC Design Model based on Flipped Learning and Patterns: A Case on Introductory Courses

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## ABSTRACT

The widespread discussion about the potential of MOOCs has stimulated universities and enterprises to develop courses using private MOOC providers and mainly open MOOC platforms on their own technological infrastructure. Nevertheless, the design of attractive courses for large scale e-learning and practical guidelines to design for learning in MOOCs remain a challenge. In this paper, firstly, we describe a general MOOC life cycle process what can be used to guide the general design and development of courses in this context. Secondly, we investigate how Flipped Learning (FL) teaching strategy and related principles could be used to support the planning phase of this process, acting as an intervention to the current design for learning in MOOCs. Finally, based on previous findings we move towards the conceptual definition of a MOOC Design Model, an approach for recording design experience in the form of a pattern language. To illustrate the applicability of the proposed model, a case study is presented about the design and the implementation of an introductory course. Current results demonstrate, in a practical context, the feasibility of using FL principles to design for learning in open and online courses. The most significant improvement to the pedagogical discussion is the proposal for a new perspective to re-think the virtual moment in the MOOC platform and optimize it using active learning activities.

## Categories and Subject Descriptors

K.3.1 [Computers and education]: *Computer Uses in Education: Collaborative learning, Distance learning.*

## General Terms

Design, Experimentation, Theory.

## Keywords

Massive Open Online Courses; Flipped Learning; Flipped Classroom; Learning design; Introductory courses; Active Learning; Case-based learning.

## 1. INTRODUCTION

Massive Open Online Courses (MOOCs) are an instance of the Open Education Movement offering unlimited participation to students and open access via the web [6, 11, 17]. The term MOOC was used for the first time in 2008 to describe a connectivist course offered by the University of Manitoba, Canada. This course and its successors led to the development of a MOOC model named cMOOC.

Since 2012, the popularity of MOOCs has increased considerably mainly due to new educational and technological MOOC experimental providers developed by American and European start-ups, such as Coursera ([www.coursera.org](http://www.coursera.org)), edX ([www.edx.org](http://www.edx.org)), Udacity ([www.udacity.com](http://www.udacity.com)), and Future Learn ([www.futurelearn.com](http://www.futurelearn.com)). At that time, a new model of MOOCs emerged, the so-called extensionist MOOCs or xMOOCs, which have been considered an important mechanism for democratizing access to education.

Although promising, most of the current xMOOCs are still based on traditional teaching models, which may also influence the high dropout rates experienced. Actually, designing attractive and motivating online courses for large scale delivery still remains a challenge [11]. Furthermore, the widespread discussion about the potential of MOOCs has stimulated universities and enterprises to develop courses using MOOC open platforms such as Google Course Builder (<https://www.google.com/edu/openonline/course-builder/index.html>), open edX ([open.edx.org](http://open.edx.org)), and Tim Tec (<http://timtec.com.br/>), on their own technological infrastructure. Despite MOOCs popularity, practical guidelines for learning design in MOOCs need to be further investigated to not leave instructors and educational technologists relying on their own experiences when developing MOOCs [30].

In our previous research [3, 21, 22], we investigated how the Flipped Learning (FL) teaching model could be incorporated into the MOOC design in order to enhance the learning experience and increase student's engagement. Specifically, we investigated how Flipped Learning and related fundamentals could derive design guidelines to be used by instructors and MOOCs teams to design more pedagogically informed MOOCs, helping students to take an active role in their own process of acquiring skills and constructing knowledge.

Flipped Learning is an educational strategy that has been applied in face-to-face environments. There is no widely accepted definition of FL and some authors also use the term Flipped Classroom to define it, but, what usually happens is an inversion between in-class and out-of-class activities: at first, students learn new content by reading and watching video lectures at home; and then, they do exercises and group activities in the classroom with instructor mentoring [7, 3]. However, this simple re-ordering or re-organization of learning activities is just one possible strategy to apply the FC concept. Actually, FL represents an expansion of the curriculum, rather than a mere re-ordering of activities. It is based on several theories linked to learning and pedagogy, which emphasize the interactive and collaborative learning. FC also offers an alternative way to promote the use of active learning

activities, such as Project-based Learning and Problem-based Learning [42], and represents a broad shift in the way we think about the process of teaching and learning.

The main purpose of this work is to move forward the definition of a design model supported by an intervention strategy to guide the design for learning in MOOCs. The proposed intervention is named Flipped-Based MOOC Learning Model and can be incorporated into the planning phase of a MOOC life cycle process. In this paper we discuss the theoretical framework underpinning our approach and define (i) the MOOC life cycle and (ii) the Flipped-Based MOOC Learning Model, and (iii) represent the proposed MOOC Design Model, based on (i) and (ii), using a pattern language. We demonstrate the use of the design model in the course design context considering a case study that illustrates its application on the design of introductory open online courses.

According to Nulden [2], introductory courses are often designed according to the sequential model, with lectures, self-study, and practice as the main building blocks. The aim of introductory courses is often to give students the “big picture” or overview of a field. Nulden [2] also suggests that introductory courses are usually large heterogeneous classes. Students have very different backgrounds and their reason for taking the course varies, and they surely have very different levels of motivation. Thus, in this work, we also suggest an alternative view on designing introductory MOOCs.

This paper is organized as follows. Section II provides information about the research method used to develop our work. In Section III, we present some conceptual ideas used to formulate a MOOC life cycle process and Flipped-Based MOOC Learning model to support the planning phase in this process. These ideas form the basis of the MOOC Design Model outlined in Section IV. A case study based on this design model is presented on Section V. Finally, Section VI summarizes our contributions and provides insights for future work. Both, methodological steps towards a MOOC design model and the demonstration of the proposed model as well as its preliminary findings are useful for MOOC designers and educational technologists.

## 2. RESEARCH METHOD: EDUCATIONAL DESIGN RESEARCH

Educational Design Research (EDR) is based on a set of approaches that can be used to produce new theories, artifacts, and practices to represent and potentially affect learning and teaching [4].

According to Anderson and Shattuck [5] and Van den Akker [32], EDR is useful to support and guide studies what (i) are situated in a real educational context, (ii) are focused on the design and testing of a significant intervention, and (iii) try to produce design principles and enhance solution implementation, among other characteristics.

EDR was chosen to guide this study because it addresses an educational real-world problem and also tries to explore the characteristics of an intervention in the context of design for learning in MOOCs in order to produce clear design guidelines.

Figure 1 summarizes the main activities developed and described in the next sections. They are related to the interactive process defined from [4] and [5] and were used to analyze, design, validate, reflect on feedback and present a set of guidelines to design for learning in MOOCs based on Flipped Learning ideas.

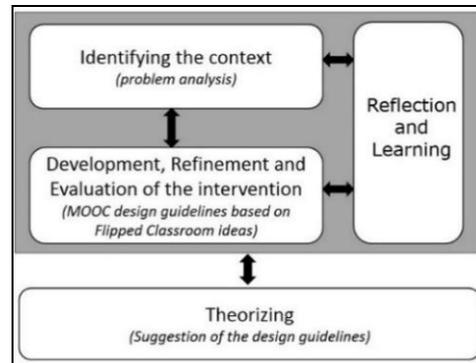


Figure 1 - Educational Design Research interactive process adapted from [4, 5].

In general, the context was identified and the problem was defined considering the analysis obtained from (i) a systematic review on MOOCs [17], (ii) a basic review on Flipped Learning and two experiments on Flipped Learning and Computer Science in a face-to-face environment [21, 22], (iii) a study on strategies to design for learning in MOOCs and a basic review of the use of patterns and a pattern language for recording design experiences [31].

The development and refinement of the model were divided into two main parts. Firstly, the contextualization of a MOOC life cycle process, similar to other strategies to design units of learning (i.e. ADDIE model), with respect to the design phase, but guided by Flipped Learning Teaching Method as a pedagogical base. Secondly, this ‘blueprint’ was used as the base for the development of a MOOC Design Model based on patterns.

In the evaluation stage, an experimental case study was developed and the intervention was initially tested in e-classroom settings considering an introductory open and online course.

## 3. THEORETICAL FRAMEWORK

The theoretical framework for this study draws upon two areas of education research: (i) strategies to design for learning in MOOCs and (ii) the Flipped Learning teaching model. Together, they provide insights that we used to explain a conceptual model for educators to design and develop MOOCs based on Flipped Learning fundamentals and represented through patterns.

### 3.1 Strategies to design learning in MOOCs

Learning design or design for learning can be defined as the act of devising new practices, plans of activity, resources, and tools aimed at achieving particular educational goals in a given situation [12]. Kober and Olivier [37] also define ‘learning design’ as

[...an application of a pedagogical model for a specific learning objective, target group and a specific context or knowledge domain. The learning design specifies the teaching-learning process. More specifically, it specifies under which conditions, what activities have to be performed by learners and teachers to enable learners to attain the desired learning objectives.]

Strategies to guide and describe learning design have different names, such as lesson plan, course scripts, and frameworks.

In order to understand how instructors are designing for learning in MOOCs, firstly we conducted a systematic review; then, to decrease bias, we also did a data triangulation using a questionnaire with instructors who performed MOOCs [31].

As a result, we identified two specific approaches:

- MOOC Canvas is a conceptual visual participatory framework inspired by Business Model Canvas for supporting educators in the description of MOOCs in two steps: assessing available resources and making design decisions based on available resources [13].
- MOOC Design Patterns Project uses the Participatory Pattern Workshop (PPW) methodology [14] to review and to examine practitioners' experiences of designing, delivering and facilitating MOOCs. Transferable design knowledge is extracted from these experiences in the form of design narratives and design patterns.

In addition, general approaches applied to design MOOCs were also identified:

- Carpe Diem learning design process is a type of workshop model, which is broken up into six sequential, progressive and collaborative tasks, led by a trained facilitator familiar with the process [15]. The six steps are: (i) write a blueprint, (ii) make a storyboard, (iii) build your prototype online, (iv) check reality, (v) review and adjust, (vi) plan the next steps.
- Learning Design Studio (LDS) methodology is a collaborative, blended, project-based framework based on the Design Inquiry of Learning (DIL) method for training teachers in the evidence-based use of educational technology [16].

However, in a general way, MOOC teams are using ad hoc decisions, institutional or MOOC provider's guidelines to design for learning in MOOCs [31].

### 3.2 Flipped Learning as a pedagogical model to guide the design for learning

Kim et al. [40] define Flipped Learning as “an open approach that facilitates interaction between students and teachers, and differentiated learning by means of flipping conventional events both inside and outside of the classroom and supporting them with digital technologies”.

Flipped Learning incorporates a number of strategies for engaging students out and in-classroom (Fig. 2). These strategies may also provide instructional designers with new ideas for engaging learners even in virtual environments [3].

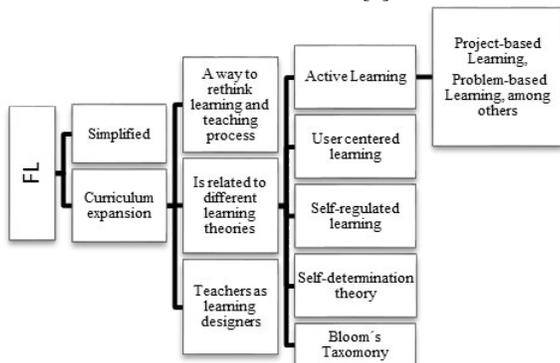


Figure 2 - Flipped Learning: definition and related theories.

Figure 3 presents a general scenario in which the behavior of MOOC users studying in a course designed based on Flipped Learning principles is presented.

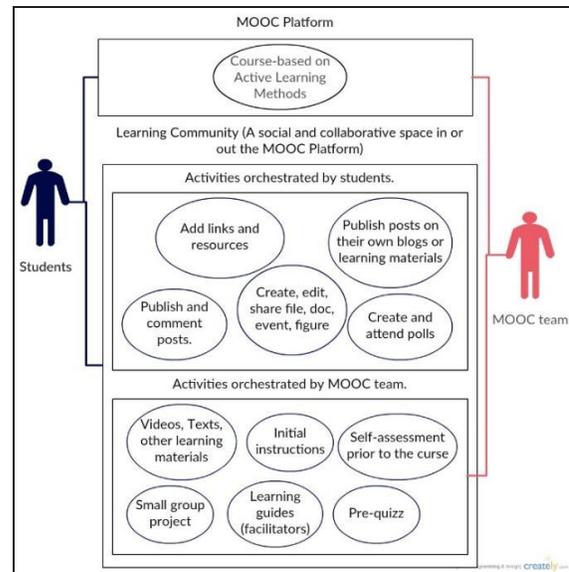


Figure 3 - Use case model for learning in a MOOC designed on the guidance of Flipped Learning.

In this model, two environments are considered:

- 1) A MOOC platform provides support for xMOOCs, such as Coursera, MiríadaX, Tim Tec, Udacity, among others. Course-time in the platform is used for deeper engagement with active learning activities, such as Project-based learning, Problem-based learning, among other methods, with the guidance of instructors and tutors.
- 2) A social and collaborative learn space embedded in or outside the MOOC platform where (i) users share generated content, or identified resources, to support activities planned by the MOOC team through the course and during social network use, (ii) MOOC team presents initial instructions, or learning guides, that act as facilitators, (iii) additional tasks can also be used to activate prior knowledge and prepare students for the course, such as pre-quizzes; videos to be watched and/or discussed using comments on the videos, for example; small group project; group discussions and instructor's review of group discussions; development of an online library resource; self-assessment prior to the course. In short, this is a learning community space where the generated resources are organized, acting as an opportunity to activate prior knowledge and prepare students for taking active part in the course.

In the illustrative case study described in this paper, we only consider two main strategies related to Flipped Learning ideas, which are described next: (i) the moment prior to the course, and (ii) the course itself, considering the use of active learning methods, specifically an inductive-based instructional method to support the design of introductory courses:

- a) The moment prior to the course

Considering the influences of Bloom's Taxonomy [36] on the Flipped Learning fundamentals, students take lower-order cognitive work before and out of the classroom, while higher-order cognitive work occurs during class time. Before-class strategies can also be applied in the context of MOOCs once the moment prior to the course is very important to stimulate an active attitude towards own learning and independent learning. Additionally, if the MOOC platform provides learning analytic tools, instructors

can also use meaningful data to understand what students have learned about the course's subject in a moment prior to the course and potentially inform further design.

Before-course activities in our illustrative case study include a quiz, presentation video showing how the course works, and questions to instigate user's reflection about some issues before accessing the course moment.

b) Active learning activities: Deductive and Inductive teaching

According to Prince and Felder [1], and Nulden [2], in the deductive teaching approach, teachers usually begin with lectures presenting basic principles and proceed with repetition and application of the lecture's content by the students. At the end of the lectures (or during the lectures, as in-quiz videos), teachers ask questions and expect the student to provide an answer, which is either right or wrong. They act as a filter, searching the information, organizing it and, then, transmitting the content to students. Thus, students are the passive subjects of their own learning process. Prince and Felder [1] reinforce that the overall objective of the teacher is to communicate the necessary body of knowledge in student's mind.

Otherwise, using an inductive approach, teachers can start with observations to be interpreted, questions to be answered, problems to be solved, or case studies to be analyzed by students. The literature also demonstrates that inductive methods encourage students to adopt a deep approach to learning and that the challenges provided by inductive methods serve as precursors to intellectual development [1].

Examples of inductive-based instructional methods include Inquiry learning, Problem-based learning, Project-based learning, Case-based learning, Discovery learning, and Just-in-time teaching.

We used the guidelines proposed by Prince and Felder [1] to decide about the use of Case-based learning strategy in our context (an introductory course about MOOCs) combining it with Flipped Learning-based experiences. So, in this paper, we will describe the Case-based learning strategy as defined by Prince and Felder:

“In Case-based teaching, students analyze case studies of historical or hypothetical situations that involve solving problems and/or making decisions. Analyzing complex authentic cases, the students become aware of the kinds of situations and dilemmas they might have to face as professionals, gain both theoretical and practical understanding of their subjects, develop critical reasoning skills, explore their existing preconceptions, beliefs, and patterns of thinking, and make necessary modifications in those preconceptions, beliefs, and patterns to accommodate the realities of the cases. However, being totally qualified as an inductive instruction depends on how it is implemented. In this context, a case cannot teach critical thinking and decision-making skills. Circumstances can be described, but not the decisions made.” (Prince and Felder, 2006).

#### 4. TOWARDS A MOOC DESIGN MODEL BASED ON FLIPPED LEARNING AND DESIGN PATTERNS

The MOOC Design Model proposed in this work is represented through a pattern language. To achieve this pattern language, we identified requirements from main activities when designing and developing MOOCs using a MOOC life cycle process. The process's planning phase is based on Flipped-Based MOOC Learning Model. To illustrate this idea, in this section we firstly describe a MOOC life cycle process to design MOOCs. Then, we explore Flipped-Based MOOC Learning Model, which is part of this process. Finally, the MOOC Design Model is outlined.

#### 4.1 A MOOC life cycle process

Figure 4 presents the main phases of a general process to design MOOCs that consists of a set of commonly linked and complementary fundamental theories from the perspective of instructional design, education and educational technology to support teaching and learning practices in MOOCs. The process is, in turn, defined in terms of phases and activities. Some activities are broken down into a set of tasks.

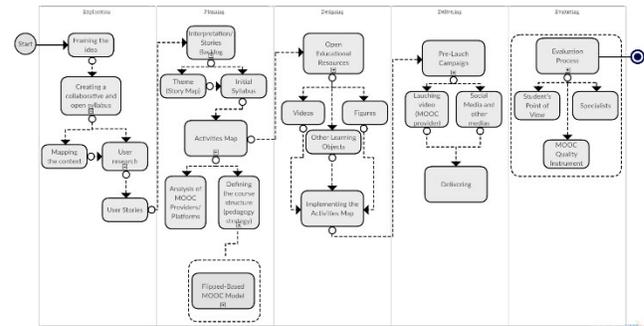


Figure 4 - A general process to design and develop MOOCs.

During the Exploration phase, the MOOC team needs to understand the teaching/learning challenge by diving into the context and the course audience. Members of the target audience may be invited to write stories about what they want to learn, what they need and how they want to do it. This is a type of pre-survey and can be sent to the target users by e-mail or can be available in the course's main page in the MOOC platform. In this phase is also important to identify the university needs in order to define the business model as well as the delivering mode; for example, choosing the platform and the teaching type (formal/informal).

The Planning phase, in turn, serves to decide which stories have to be implemented and which can be left for later. In this case, the stories will help the MOOC team to define the syllabus and design the MOOC learning model, it means the main pedagogic structure used to identify interdisciplinary opportunities, define instructional goals and develop the Activities Map. According to Filatro [9], Activities Map is a resource created during the Planning phase of an educational design process and contains the organization of classes as well as the learning outcomes to be achieved by the students considering the activities proposed in the map. The map can be organized in a table with rows and columns, which aims to present an overview of the dynamics of the learning in the course.

During the Designing phase, the stories selected in the Planning phase are implemented using some MOOC provider (i.e. Coursera, Veduca, and Future Learn, among others) or a MOOC open platform (i.e. Tim Tec, Google Course Builder, and open edX<sup>1</sup>). Lastly, the Delivering phase consists in running the MOOC. Evaluation activities can be performed during all phases of the process. The MOOC can be tested using the quality assurance methods formulated by specialists and considering the perceptions of the target public.

<sup>1</sup>The definition of MOOC providers and platforms was explored in Fassbinder, Delamaro, and Barbosa [17].

## 4.2 Flipped-Based MOOC Learning Model

Considering the MOOC life cycle process (Fig. 4), a MOOC learning model should be defined in the Planning phase. In this section, the Flipped-Based MOOC Learning Model is outlined as an option to guide the design for learning in MOOCs in order to enhance the learning experiences, increase student's engagement in the course, and emphasize self-directed learning [43]. The model could be useful to support the task "Defining the course structure (pedagogy strategy)" in the Planning phase, which will help instructors and MOOC teams to create the Activities Map.

The preliminary version of Flipped-Based MOOC Learning Model consists of an initial set of design guidelines organized to provide insights and guidance to help MOOC teams to make effective design decisions when creating learning experiences based on Flipped Learning ideas. They were initially derived from Flipped Learning design principles investigated in our previous studies on Flipped Learning [3, 21, 22] as well as from relevant literature [39, 40, 41], and are presented in Table 1.

Table 1 – Set of initial design guidelines for MOOCs considering the moment prior to the course, the course itself and general ideas.

Moment prior to the course	
FL design principles	Design guidelines for MOOCs
Provide an opportunity for students to gain first exposure to content prior to classes.	On-line "pre-quizzes" designed to prepare students for follow-on course discussions. Watching and exploring on-line learning materials (e.g., online video lectures); comments on the videos. Small group project. Group discussions and Instructor's review of group discussions. Collaborative development of an online library resource (e-repository). Self-assessment prior to the course.
Provide an incentive for students to prepare for course.	Students who prepared before engaging with the in-course activities should be rewarded. The MOOC platform should provide mechanisms to identify their pre-participation.
Provide a mechanism to assess student understanding	Low-stakes short quizzes (3–5 multiple choice questions) and other forms of formative assessment. Questions intentionally made simple.
Provide clear connections between in-classes and out-of-classes activities.	Questions that were posed before the course could guide complementary tasks and learning content in the course.

Flipped Learning requires a shift in learning culture.	Additional learning objects could be specifically created to explain to users how the course works, for example the importance or the development of time management skills. Use reflective activities to have students think about what they learned, how it will help them, and its relevance. Give students a reason to be prepared before the course.
In-MOOC learning space (Course)	
FL design principles	Design guidelines for MOOCs
Provide enough time for students to complete the assignments	Encouraging the development of user skills in self-regulation learning. Use of Self-Paced <sup>2</sup> MOOCs.
Use of Active learning approaches in-course.	Project-based learning, Project based learning, among others. Problem solving individual and in small groups. Discussion of group projects.
Provide prompt/adaptive feedback on individual or group works.	This is a difficult task in the context of MOOC, but teams could use feedback resources available in the platform: automatic e-mails, automatic feedback related to formative questions (true or false, multiple choice, among others). Discussion in peer can also be used, active users could be invited to act as tutors.
General	
FL design principles	Design guidelines for MOOCs
Provide clearly defined and well-structured guidance.	The MOOC platform should provide a clear course structure with supporting tools such as guiding prompts. The MOOC team should use a clear set of instructions and a structure to reinforce the connections between the in-course activities and the out-of-course activities. Employ the task-oriented environment supported by a well-designed structure that clearly guides students to solve given problems.

<sup>2</sup> The learner can start and complete learning activities at any time and on their own speed.

Provide facilitation for building a learning community	Provide students with moments to take in new ideas by learning before, during, and after the course: group works, peer assessment, presentation forums (icebreaker strategies), learning community.  Motivate community and collaborative learning culture.
Provide technologies familiar and easy to access	Integrate technology into pedagogy is much more important than mere technology use. MOOC teams need to consider the cultural diversity of users when choosing social media and other additional tools to complement or support learning in the MOOC platform.

The guidelines were organized according to Fig. 5:

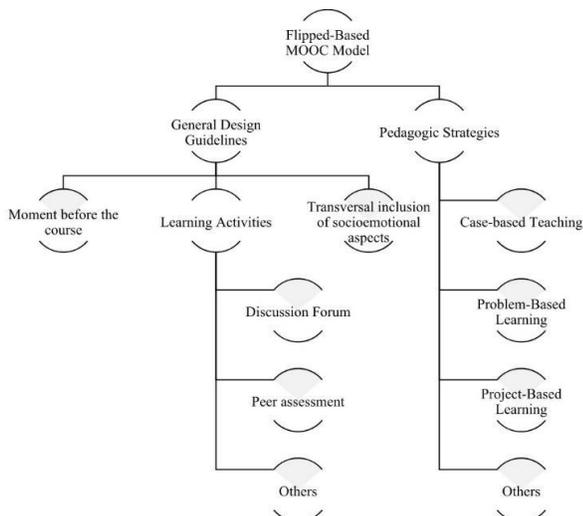


Figure 5 –Outlining Flipped-Based MOOC Learning Model.

### 4.3 The proposed MOOC Design Model

Considering figures 4 and 5, it is possible to identify basic tasks or activities that teams need to carry out to design and deliver a course based on the Flipped Learning ideas. These tasks can be further expressed in the form of requirements; for example, requirements to develop adequate videos for MOOCs, to include transversal and socioemotional aspects in MOOCs, to implement a Project-based MOOC, among others.

Therefore, if we consider the requirements as problems that MOOC designers have to solve, we can find appropriate best practices in existing MOOC design strategies that provide a solution to these problems. Furthermore, best practices, practitioner experiences, and their relationship can be formalized or described using learning design patterns and pattern languages [18]. The MOOC community has not yet initiated an attempt to establish a formal repository of patterns for its own domain. Thus, this work also aims to move research steps towards that direction

and begins recording design experience in the form of learning design patterns for MOOCs.

According to Alexander et al. 1977 [18],

[...a pattern describes a problem which occurs over and over again in our environment, and then describes the core of a solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice. Learning design patterns is an approach that looks to architectural design patterns as a way to capture knowledge from designers and share it with practitioners]

And, considering Braga and Masiero [19, 20], and Brugali and Sycara [40], a pattern language is a structured collection of patterns that build on each other to transform needs and constraints into an architecture. Pattern languages represent the temporal sequence of decisions that lead to the complete design of an application, so they become a method to guide the development process.

There are many pattern description formats. The GOF and the Alexandrian Templates are some examples. Braga and Masiero [19, 20] suggest a variation of the Alexandrian template that contains the following fields:

1. Name: a unique name to distinguish the pattern.
2. Problem: a brief description of the design problem.
3. Motivation: an explanation of the origins of the problem, probably with an example for better communicating it. It may also contain the context of the particular problem, if it is necessary, in order to make it more comprehensible.
4. Solution: a description of the solution proposed by this pattern that addresses the problem and motivation stated earlier.
5. Related Patterns: other patterns that are related to this one in some way.

Table 2 describes a simple example of a pattern, considering the application of the Case-based teaching. This pattern will be used in Section V.

Table 2 - Pattern to apply Case-based teaching (description adapted for MOOCs from Prince and Felder, 2006).

Name	Case-Based teaching
<b>Problem</b>	MOOC team needs to cover in the course some subjects related to historical or hypothetical situations that involve solving problems and/or making decisions.
<b>Motivation</b>	The use of case studies enhances students' ability to recognize multiple perspectives and the use of cases develops students' ability to identify relevant issues. This also increases the use of higher-order thinking in line with Bloom's taxonomy.
<b>Solution</b>	(1) Review of the case content, (2) statement of the problem using different learning objects to attend several learning styles, (3) collection of relevant information, (4) development of alternatives, (5) evaluation of alternatives using peer review, discussion forum, among others, (6) selection of a course of action or final project, and (7) evaluation of solutions through peer review, and possibly review of actual case outcomes.
<b>Related Patterns</b>	It must be considered the complete process.

Considering (i) the MOOC life cycle process, (ii) the Flipped-Based MOOC Learning model, and (iii) ideas beyond the formalization and best practices through patterns and their relationship using a pattern language, Figure 6 summarizes a conceptual model of a learning design pattern language to represent the general MOOC Design Model proposed in this work.

All groups of patterns initially presented are connected, but, due to space constraints, directions and hierarchy are not presented herein. Moreover, items related to each group have not been extensively described.

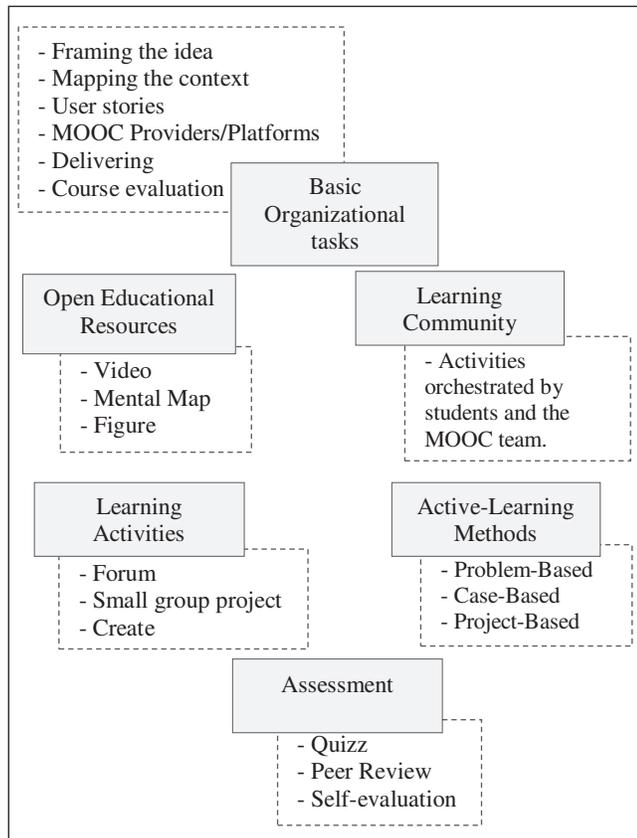


Figure 6 - The proposed MOOC Design Model described through a conceptual pattern language.

The application of this model (conceptual pattern language) can be understood considering the hierarchy presented in Figure 7. This hierarchy of representations begins with the MOOC life cycle process originated from general strategies to design MOOCs with the Flipped-Based MOOC Learning Model supporting the design for learning in this process' planning phase. The process/learning model is a source of activities, whose solutions based on best practices, experiences, and their relationship can be expressed through a pattern language. At a lower level are instantiations based on how these patterns are interpreted, matched, and finally delivered in a suitable MOOC provider (e.g. Coursera, edX, Future Learn, Veduca) as well as open MOOC platforms (such as open edX, Google Course Builder and Tim Tec platform).

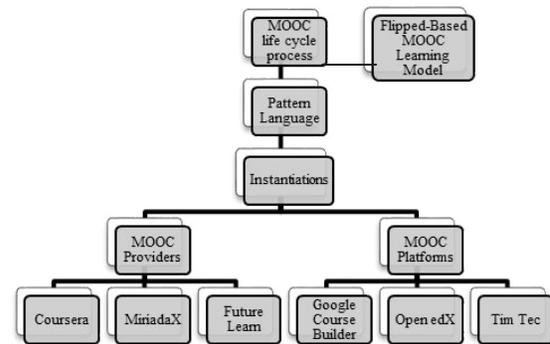


Figure 7 - Patterns as part of the MOOC learning design process. (Adapted from McAndrew, Patrick and Peter Goodyear, 2004)

## 5. AN ILLUSTRATIVE CASE STUDY ON MOOC DESIGN

This section describes the design of an introductory course about MOOCs, named “Exploring the MOOCs”. In fact, it is a meta-MOOC, a MOOC to instigate discussion on the history and fundamentals of MOOCs. The course was designed considering all activities performed towards the conceptual definition of the MOOC Design Model, previously summarized.

### 5.1 Exploration

#### 5.1.1 Framing the idea

The Federal Institute of Education, Science and Technology of South of Minas Gerais - IFSULDEMINAS, which is an educational institution located in the southeast of Brazil, is preparing its technological and human infrastructure to deliver MOOCs mainly using Tim Tec Platform<sup>3</sup>. Tim Tec (Fig. 8) is a Brazilian open source MOOC platform that can be installed by any person or organization - schools, universities, collectives, businesses, among others.



Figure 8 - Tim Tec, a Brazilian open MOOC platform.

The platform also has a database of courses that follow the Open Educational Resources (OERs) guidelines [23]. Videos on Tim Tec platform's courses are licensed under Creative Commons attribution 4.0 International (CC BY 4.04). This license enables any content published on the internet to be used freely without the need for direct authorization by the author. In a general way, institutions can use the available courses or they can use the platform just to deliver their own courses.

<sup>3</sup> <http://timtec.com.br/pt/download/>

<sup>4</sup> <https://creativecommons.org/licenses/by/4.0/>

Initially, in order to understand the current knowledge of the IFSULDEMINAS's community about MOOCs, mainly the administrative and educational staff (teachers), an online questionnaire was distributed. We obtained data from 112 people (Fig. 9): 37.5% said they did not know what MOOC stands for, while 37.5% said they have heard about MOOCs but are not sure what they really are.

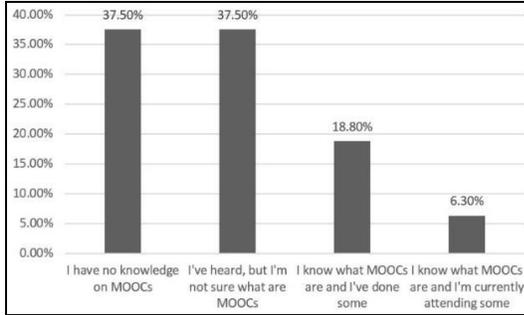


Figure 9 - IFSULDEMINAS's community knowledge on MOOCs

Considering this context and the lack of introductory courses about MOOCs in Tim Tec database and even in other MOOC providers, we chose to develop an introductory course about MOOCs.

### 5.1.2 Mapping the context

Introductory courses, in general, provide an overview of a particular subject domain. In order to understand how introductory massive open and online courses are developed, we performed an initial explorative study across introductory courses from Coursera and Tim Tec, analyzing their learning designs and considering the main ideas defined in [34]. MOOCs from Coursera were selected since this is one of the most important course providers currently. Courses from Tim Tec were elected once this case study used such platform for delivering our course.

Firstly, the following research question was defined: "What activity types are used in the context of open and online introductory courses?". Secondly, we analyzed learning design considering the guidelines beyond the deductive and inductive teaching approaches and the following parameters: type of activities and the number of hours that students are expected to study in each activity, which is difficult to measure as student start their learning journey at various different points and as a consequence, vary in the amount of time that they need to meet the assessed learning outcomes [33, 34]. The Learning design activities considered were described in Rienties and Toetenel [35] and summarized in Table 3.

Table 3 - Learning design activities [35].

	Type of activity	Example
<b>Assimilative</b>	Attending to information	Read, Watch, Listen, Think about, Access.
<b>Finding and handling information</b>	Searching for and processing information	List, Analyze, Collate, Plot, Find, Discover, Access, Use, Gather.
<b>Communication</b>	Discussing module related content with at least one other person	Communicate, Debate, Discuss, Argue, Share, Report.

	(student or tutor)	Collaborate, Present, Describe.
<b>Productive</b>	Actively constructing an artefact	Create, Build, Make, Design, Construct, Contribute, Complete.
<b>Experiential</b>	Applying learning in a real-world setting	Practice, Apply, Mimic, Experience, Explore, Investigate.
<b>Interactive /adaptive</b>	Interactive /adaptive	Explore, Experiment, Trial, Improve, Model, Simulate.
<b>Assessment</b>	All forms of assessment (summative, formative and self-assessment)	Write, Present, Report, Demonstrate, Critique.

It is a labor intensive process [34], but from this mapping process we realized common patterns in the way educators design open and online introductory courses. As a result, a total of 15 learning designs of courses were studied and we found evidence that, in general, introductory MOOCs are traditionally taught deductively. There are videos where the instructor introduces a topic by lecturing on general principles, then uses forums and quiz to test the student's ability to answer the questions considering the content explained in videos. Figure 10 highlights educator's preferences for using assimilative and assessment activities in the learning design of introductory courses in Coursera and Tim Tec platforms. The number of hours spent by students to develop these activities is also high.

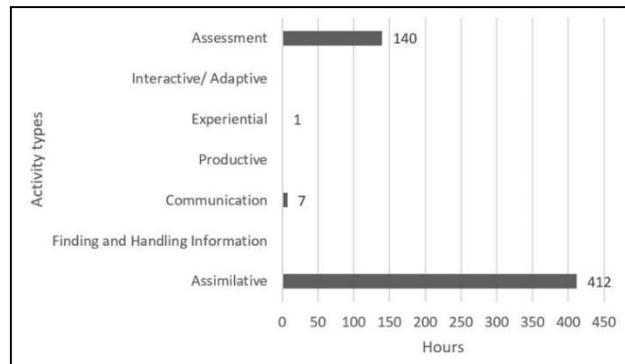


Figure 10 – Average of Learning design activities per hour in traditional online introductory courses in Coursera and Tim Tec.

### 5.1.3 User research – User stories

In order to understand what the target audience needs about MOOC context, an online questionnaire delivered to IFSULDEMINAS' staff was also used to collect personal questions (genre, age, education degree) and specific questions about MOOCs, such as their knowledge level on MOOCs, what subjects and learning activities an introductory course on MOOCs should cover, last learning experiences in MOOCs, among others.

## 5.2 Planning

### 5.2.1 Theme (Story Map)

We used a mind map to resume and organize the main needs, curiosities, suggestions as well as characteristics and content appointed by the target audience. In the MOOC life cycle process (Fig. 4), this is named “stories”.

Specific content ideas to be addressed by an introductory course were divided according to the main personas identified through the pre-survey: administrative staff (how to use MOOCs to advance in my institutional career), students (hot to use MOOCs to do academic and scientific research), and teachers (MOOCs to support classroom, pedagogical strategies to adopt them, and how to create and deliver MOOCs). Common core content was also mapped: how to find specific courses, MOOC x Virtual Learning Environments, history and current landscape of MOOCs, MOOC platforms, and assessment in MOOCs.

The target audience also suggested MOOC characteristics to be addressed: step by step videos, content presented in different ways, texts and videos based on real experiences, learn by doing, collaboration with colleagues, among others.

### 5.2.2 Initial Syllabus

The initial syllabus was defined considering results obtained from the previous step as well as the study of MOOCs: history and overall picture of MOOCs; how MOOCs are defined or characterized; format/types of MOOCs; platforms, providers, and courses; and applications of MOOCs in different contexts.

We also did an online focus group to discuss this syllabus. The group was formed by one instructor, one teacher from the educational area, and 10 volunteer members of the target audience who answered the online questionnaire delivered to the staff of IFSULDEMINAS. In order to select volunteer members, we adapted a lead user identification method defined in [8]. Lead users are considered a valuable source of innovation, but they are not easy to detect. Thus, the following sentences were also included in the questionnaire previously mentioned.

- In general, I am part of the group of people who first test or experience new virtual courses or other online resources to learn some content for the internet, mobile devices, etc.
- To this date, my expectations doing virtual courses have not been satisfied.
- Within my contact network (friends, classmates or business), I am considered an "expert" in using virtual courses or other online resources to learn something.
- I am quite familiar with the use of MOOCs to learn some content.
- I care about the direction of distance education as well as MOOCs, mobile learning, etc.
- I am usually very active in discussions or conversations about online courses and other online resources to learn some kinds of content.

These sentences represent the following top user attributes or characteristics, in this order: Ahead of a trend, Dissatisfaction, Product-related knowledge, Use experience, Involvement, and Opinion leadership. To measure the top-six user attributes, we used multiple items on Likert scale (Strongly Agree, Agree, Neither Agree nor Disagree, Disagree, Strongly Disagree). The first 10 individuals with the highest score were considered.

### 5.2.3 Analysis of MOOC providers/platforms

Our MOOC was created and delivered using Tim Tec MOOC Platform<sup>5</sup>. Tim. In Tim Tec, classes are the central components of the courses and they are responsible for the content. Classes are composed of units. Each unit requires a video. Activities are optional in the units. There is no support for peer assessment or internationalization. We used Portuguese as the main language to develop videos, texts, and other learning materials.

### 5.2.4 Defining the course structure - Activities Map

Considering the main syllabus and Tim Tec available resources, we used Flipped-Based MOOC Learning Model to develop the activities map related to the course “Exploring the MOOCs”. We specifically used ideas from Flipped Learning and Case-based teaching method described in the Subsection 3.2, and design guidelines presented through the pattern described in Table 2.

The map’s main topics, learning outcomes (objectives), and activities are described in Table 4. Objectives were defined by considering Bloom’s Taxonomy [36].

Table 4 - An overview of the Activities Map for the course "Exploring the MOOCs"

Class/Topic	Objectives	Activities
Before the course		Quiz, presentation video showing how the course works, and questions to instigate user’s reflection about some issues before accessing the course moment.
Welcome class		Welcome video; Pre-Survey; Presentation forum; Additional readings.
History of MOOCs	Knowledge and Comprehension	Presentation video (resume of the class); Reading about the Open education movement; Case-based video: connectivist MOOCs; Discussion forum; Further discussion.
Types of MOOCs	Analyze (Compare and Contrast)	Presentation video (resume of the class); Case-based video: examples on MOOC providers (NovoEd, Udacity, Coursera); Practical activity; Discussion Forum.
Platforms, Providers and Courses	Analyze (Compare and Contrast)  Evaluate (Judging the Outcome)	Presentation video (resume of the class); Case-based videos on MOOC open platforms (Google Course Builder, open edx, Tim Tec); Case-based video:

		examples on MOOC providers (MiríadaX, Future Learn); Practical activity; Quiz.
Real Experiences (Applications)	Create (Original or new creation) Design, invent, imagine, present, plan, and formulate.	Presentation video (resume of the class); Case-based videos on real applications and experiences performing MOOC; Practical final course activity (presenting your own idea to apply or use MOOCs in your context).

### 5.3 Designing

Tim Tec is a platform that motivates the development of MOOCs based on delivery of content mainly through videos.

In the design phase, specific videos for the course were recorded and edited using the university media service. The videos were developed considering best practices when producing multimedia online videos for MOOCs [24, 25].

The content in each week consisted of approximately five or six small videos from one up to five minutes of duration.

All the learning materials used in the course, such as videos, images, and texts, were also based on common Open Educational Resources (OERs) guidelines [23]. Finally, the activities map (Table 4) was implemented in Tim Tec platform.

### 5.4 Delivering

The course was launched in April 2016 and stayed online for 5 weeks. About 100 users were registered in the course, including students from IFSULDEMINAS face-to-face courses, teachers, and administrative staff.

When the course opened, all lessons were released. Although students were encouraged to follow the prescribed timeline of activities, they were free to complete the course at their own pace.

The week prior to the course site being opened by Tim Tec platform was called “Before starting the course”. It was reserved to introduce some initial questions to students and to motivate them to reflect on the concepts discussed during the course.

Students used the forum to introduce themselves and a ‘Getting to know you’ questionnaire was also distributed by email to enrolled students. The pre-course survey focused on demographic and personal information, the current knowledge on MOOCs, and student motivations for taking the course. A summary of the main collected data is presented next:

- **Brazilian state of origin:** Minas Gerais (68.8%), Piauí (6.3%), Santa Catarina (6.3%), São Paulo (6.3%), Bahia (12.5%).
- **Genre:** 75% male and 25% female.
- **Occupation:** Teachers (37.1%), Administrative staff (12.5%), Postgraduate students (6.3%), undergraduate students (18.8%), High-school students (6.3%), Self-employed (18.9%).

### 5.5 Evaluation

It is difficult to evaluate MOOC quality in the same way as any defined university course with traditional degree awarding process [6]. Moreover, it is important to highlight limitations concerned

with the context in which this case study was performed, since the Tim Tec platform is a Brazilian initiative still under development, and the "Exploring the MOOCs" course was the first attempt performed by instructors from the IFSULDEMINAS in the context of open and online courses.

Thus, in this study, we initially explored student’s perceptions about the related MOOC and course dropout rate.

According to Liyanagunawardena and Parslow [28], defining dropout in MOOCs is a difficult task since the term ‘dropout’ is sometimes associated with ‘all who failed to complete’ a MOOC. However, considering another point of view, sometimes participants join a course just to follow a specific topic and once they complete it they voluntarily withdraw from the rest of the course.

In a previous study on MOOC dropout, Jordan [29] provides a data compilation on the current average completion rate for MOOCs. Data from the last update (12th June 2015) show that this varies between 5% and 15%. Figure 11 presents the percentage of completion in our case study, while Figure 12 describes the average progress of students per week.

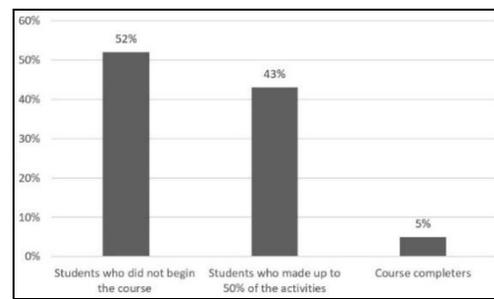


Figure 11 - Distribution of users and their situation in the course.

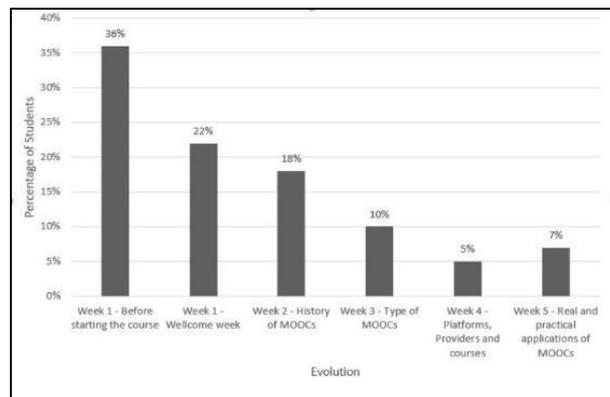


Figure 12 - Average progress of students per week.

In a post-survey, MOOC users who failed to complete the course were asked to indicate the reasons for their MOOC withdrawal decision, or explain what prevented them from becoming fully engaged. Poor time management was the main aspect mentioned by students who were not able to complete the course.

*“I have difficulty in attending this type of course due to my lack of discipline in determining schedules to get into the environment and study”.*

*“I started late and when I realized the time was already short, and other activities did not allow me to devote the necessary time”.*

Bad time management as a reason for MOOC withdrawal was also identified in other literature reviews and post-MOOC surveys as described in [26, 27].

Students also considered positive the prior activities used as a strategy to activate learning (quiz and self-assessment prior to the course).

The level of activity behavior in the forum and quiz was monitored as a means of measuring student engagement. Seventeen new topics were created by students. However, participation number of responses was still low.

As defined in Fig. 4, future evaluations on this case study should include an analysis of the course instructional quality [11], expert reviews, and the application of specific strategies to evaluate MOOCs [10].

## 6. DISCUSSION

Considering current gaps in the design of MOOCs, such as learning models based on traditional teaching methods and the lack of specific guidelines for this context, this paper presented the current landscape towards a MOOC Design Model. To achieve this goal, Educational Design Research was used to define a pedagogical model to design for learning in MOOCs. The Flipped-Based MOOC Learning Model consists of a set of design guidelines based on Flipped Learning principles and its related fundamentals, but applied in the context of MOOCs. A MOOC life cycle process was also presented to illustrate how Flipped-Based MOOC Learning Model could support its planning phase in order to guide instructors in the development of attractive and motivating online courses for large-scale e-learning.

We used MOOC Design Model main activities, including those related to the MOOC life cycle process and Flipped-Based MOOC Learning Model, to find best design experiences and best practices to perform them. Such best practices should be represented and recorded through design patterns. We also used the relationship between these patterns to outline a Pattern Language that will serve to represent the whole MOOC Design Model. More detailed patterns and the associated language will be explored and presented in further research. Thus, the MOOC Design Model represented through a Pattern Language will guide instructors and educational technologists when developing MOOCs and sharing design experiences.

An instantiation of the current version of the MOOC Design Model was also described. The case-study outlined considered the ideas previously discussed and illustrated how some of the guidelines based on Flipped Learning ideas can be used to design for learning in the context of introductory open online courses.

Deeper evaluation on the impact of the proposed model in the MOOC instructional quality still needs to be performed. Meanwhile, a previous analysis of the average of learning design activities per hour in the introductory open online courses based on our approach (Fig. 13) demonstrates a diverse use of activities when compared to the scenario in the context of traditional introductory open online courses (Fig. 10). The number of hours students need to perform each activity is also smaller using our approach.

In this paper, we considered two main strategies related to the Flipped Learning ideas: (i) the moment prior to the course, and (ii) the course itself, considering the use of active learning methods, specifically inductive-based instructional methods to support the design of introductory courses. Further research should include additional strategies to improve both prior and the course itself.

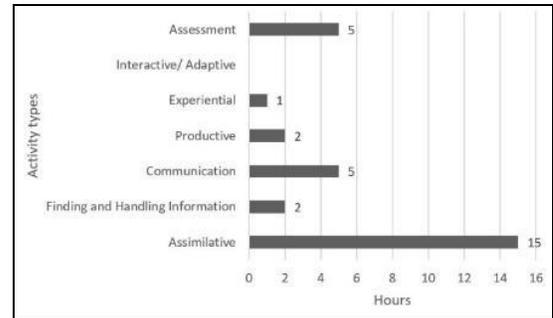


Figure 13 - Average of Learning design activities per hour in an introductory MOOC developed under the guidance of MOOC Design Model presented in this paper.

Finally, this work moved towards the definition of an intervention to the current design of MOOCs. We demonstrated how Flipped Learning could inform instructional design by looking at methods, strategies, and approaches that engage students. In the next step of our research, we will also focus on the validation and evaluation of the Flipped-Based MOOC Model. A more complete and detailed version of the Pattern Language will also be developed in order to present more design patterns and the relation between them.

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