Towards an Educational Design Pattern Language for Massive Open Online Courses (MOOCs)

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The design of innovative and groundbreaking Massive Open Online Courses (MOOCs) has been a difficult task for practitioners, especially novices, because there is no definite standard about the desirable characteristics of MOOC courses. Educational Design patterns attempt to alleviate this situation by providing instructors and MOOC teams with empirical theory-driven practices that could help them to enhance the course quality. Even though many educational design patterns have already been published, their adaptation and reuse, as well as the creation of new ones to be used by practitioners when designing MOOCs remain underexplored. The main goal of this paper is to move towards an educational design pattern language that would support learning designers and instructors when designing for learning in this context. This pattern language is a key component of an Learning Design Framework for MOOCs that we have worked on. The framework also describes a MOOC's life cycle, related artifacts, and includes digital tools. The MOOC lifecycle describes the overall MOOCs design and development process, recurring problems, and challenges that instructors face throughout the process. This paper presents a total of 49 patterns, in the form of patlets (problem-solution pair), collected from our experience with MOOC development, controlled experiments with practitioners, survey with specialists, and literature review about MOOC design guidelines. They are divided into eight main categories related to the life cycle: Exploration, Planning, Pedagogical Patterns orchestrated by Flipped Learning (general core), Patterns of Mini models of Active Learning Strategies, Patterns of Learning Evaluation and Feedback, Development, Delivery, and Course Evaluation and Improvement. In addition to providing a pattern-based approach to cover all the main phases of a MOOC's design, the pedagogical aspect of the planning phase is especially supported by a set of patterns inspired by the Flipped Learning Teaching Strategy (or Flipped Classroom). Such patterns collection offers an attractive alternative to guide the pedagogical design for learning in MOOCs in order to enhance learning experiences, increase student's engagement in the course, and emphasize self-directed learning. In this paper, all the corresponding patterns are briefly presented, and two patterns, called LEARNING MAP CREATION and FLIPPED LEARNING-DRIVEN PEDAGOGICAL DESIGN, are described in detail.

1. INTRODUCTION

Massive Open Online Courses (MOOCs) provide opportunities for socialization, collaboration, professional training, and promote lifelong learning. Because of their potential, there is a rapidly growing interest from institutions and educators in designing and delivering this type of course. Typically, this is done through popular providers, such as Coursera (coursera.org), MiríadaX (miriadax.net), edX (www.edx.org), and Future Learn (www.futurelearn.com), or by adapting, or integrating, open platforms, such as Google Course Builder (https://edu.google.com/openonline/course-builder/index.html), open edX (www.opendx.org), and the Brazilian instance named Tim Tec (timtec.com.br/pt/instalacao-e-desenvolvimento) into existing organizational infrastructures. Although there is a lot of potential, most of the existing MOOCs are still based on traditional classroom formats, which are less effective as a means of learning in this context. Furthermore, they are not designed in a way that encourages personalized and self-regulated learning, which may also contribute to the high dropout rates.

In this rapidly evolving environment, challenges have stimulated the development of strategies to support educators and learning designers when designing innovative learning experiences in MOOCs. Alario-Hoyos et al. (2014), for instance, propose the MOOC Canvas inspired by the Business Model Canvas, a popular approach in business and entrepreneurship. The patterns-based approach defined by Christopher Alexander for the architecture domain has also inspired design strategies for MOOCs. The MOOC Design Patterns Project (Warburton, 2015), for example, uses a Participatory Pattern Workshop methodology to review and examine

practitioners' experiences of designing, delivering, and facilitating MOOCs. However, according to previous studies (Fassbinder et al., 2017; Fioravanti and Barbosa, 2016), current strategies have limitations and MOOC teams are still using ad hoc procedures, institutional or MOOC provider's guidelines to design for learning in MOOCs.

In order to alleviate these limitations, a Learning Design Framework to support instructors and learning designers when designing for learning in MOOCs is under development (Fassbinder, Barbosa, and Magoulas, 2016). The framework consists of the following elements: (i) a MOOC life cycle process, which describes fundamental steps to plan, offer, and evaluate a MOOC; (ii) an educational design pattern language for MOOCs, which is based on problems and recurring solutions to solve the main activities described in the MOOCs life cycle; and (iii) related artifacts and digital tools, such as a model of Learning Map, an instrument to support the validation of learning maps in the MOOC context, a model of self-assessment and a self-reflection instrument for students who achieved all the learning outcomes of the course.

This paper presents the current version of the framework's pattern language and its related educational design patterns, which can be used as an effective way of connecting research findings with design and development practice; thus, acting as a guide to support learning designers and educators to enhance students' experiences in MOOCs.

The structure of this paper is as follows: Section 2 briefly describes the use of patterns to design for learning in MOOCs and some related works. Section 3 contextualizes the Learning Design Framework for MOOCs that contains the pattern language presented in this paper. Section 4 presents the sets of patterns and how they are organized. In Section 5, two of these patterns are described as examples following a particular template. Finally, Section 6 wraps up with conclusions and ideas for future work.

2. USING PATTERNS TO DESIGN FOR LEARNING IN MOOCS: AN OVERVIEW

Considering the use and application of patterns to describe and also to share tacit knowledge from the educational and pedagogical domain, the Pedagogical Patterns Project (www.pedagogicalpatterns.org) is among of the more significant references in this area. The project started in 1996 with the aim of collecting and disseminating experiences of teaching and learning about object technology, and has been completed recently. However, the use of the related patterns in the MOOC context requires appropriate adaptations.

The e-LEN pattern repository also created a collection of patterns but focused on traditional e-learning. This project is also completed but the patterns are still available at http://www2.tisip.no/E-LEN/patterns_info.php. The collection is organized into four special interest groups: Learning resources and LMS, Lifelong learning, Collaborative learning, and Adaptive learning.

Focusing on the specific context of MOOCs, Warburton (2015) investigated, defined, and articulated some emerging design principles and patterns that underpin the development and delivery of MOOCs through the so-called MOOC Design Patterns Project (http://www.moocdesign.cde.london.ac.uk). In general, SNaP! (Scenarios, Narratives, and Patterns) methodology implemented in the form of Participatory Patterns Workshops (PPW) was used to collect patterns and validate them. As a result, about 32 patterns were defined and categorized in five dimensions: participation, community, structure, learning, and orientation.

In another research work, conducted by Milligan, Littlejohn and Margaryan (2013), patterns of engagement and factors affecting engagement in MOOCs were investigated.

Our work differs from the previous ones because we collected and organized essential patterns to cover all the main phases of the MOOC design. We also use Flipped Learning ideas and principles as a pedagogical intervention or pedagogical architecture for MOOC projects (Fassbinder, Barbosa and Magoulas, 2016; Fassbinder and Barbosa, 2015). Although several pedagogical design patterns about Flipped Learning (or Flipped Classroom) have already been published (Köppe et al., 2015; Köppe et al. 2016), these are focusing on face-to-face environments and do not consider the use of Flipped Learning, nor can be adapted to it, to orchestrate the process of designing for learning in MOOCs.

3. A LEARNING DESIGN FRAMEWORK FOR MOOCS

In 2014, we began a project that aimed to define and validate a Learning Design Framework to support instructors when planning, designing, delivering, and evaluating a MOOC (Fassbinder and Barbosa, 2015; Fassbinder, Barbosa and Magoulas, 2016). In its current version, the framework brings together important

features and fundamentals that provide a more in-depth understanding of MOOCs. It also acts as a guide for the practical development of learning projects in this context. The framework can also be used to support research in the context of open, online, and massive courses.

The framework is based on four main concepts: (i) Massive Open Online Courses; (ii) Flipped Learning and active methodologies of teaching and learning as pedagogical strategy, (iii) Educational Design Patterns and a Pattern Language as strategy to store and share tacit knowledge, and (iv) Agile Learning Design as a strategy to reshape the main flow of the proposed MOOC learning design process.

These four dimensions guide the development and validation of the framework elements described in Section 1: (i) a MOOC life cycle process, which describes fundamental steps to plan, offer, and evaluate a MOOC; (ii) an educational design pattern language for MOOCs, which is based on problems and recurring solutions to solve the main activities described in the MOOCs life cycle; and (iii) related artifacts and digital tools.

Educational Design Research (EDR) (Van den Akker et al., 2006) has been used as a methodological approach to design and evaluate the framework and its elements. EDR is useful to support and guide studies that: (a) are situated in real educational contexts, (b) are focused on design and validation of interventions, and (c) try to produce design principles to enhance solution implementation. EDR is an interactive process composed of the following general phases: context identification and problem analysis; development, refinement, and evaluation of interventions; continuous reflection and learning through all the phases; final theorization through lessons learned, design principles, artifacts, among others.

In our work, the context was identified, and the problem was defined considering an analysis obtained from: (i) a study on current strategies to design for learning in MOOCs and their gaps, and (ii) a review of the use of patterns and pattern language for recording and sharing educational design experiences.

The development and the refinement of the Pattern Language was divided into two main parts. First, defining a MOOC life cycle process guided by Flipped-learning Teaching Method, as a pedagogical approach, but considering MOOCs characteristics as specifics adaptations. Second, both this 'blueprint' and our experience and insights from the development of three Computer Science-based MOOCs and two meta-MOOCs[1], controlled experiments with practitioners, a survey with specialists, and a literature review about MOOC design guidelines acted as a base to derive patterns and relationship between them.

At this point, the Pattern Language has been evaluated considering three validation methods. Expert's review and controlled experiments with educators, as internal validation methods; and a field evaluation with educators using the Pattern Language, as an external validation method to confirm usability, satisfaction, trustworthiness, and educational effects. Figure 1 summarizes a generic Life Cycle for MOOCs.
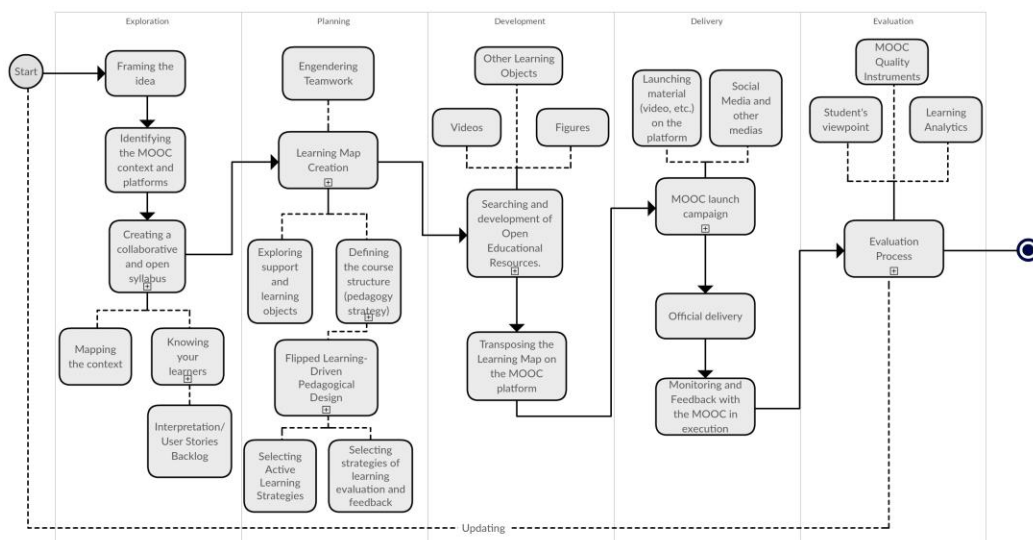

Figure 1- Generic Life Cycle for MOOCs (Adapted from Fassbinder, Barbosa and Magoulas, 2016).

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[1] "Exploring the MOOCs" and "Creating Learning Projects for MOOCs" available in Portuguese at https://mooc.ifsuldeminas.edu.br

4. THE PATTERNS AND PATTERN LANGUAGE

The MOOC life cycle model provides a top-level overview of the "what-to-do" items (i.e., phases, activities, and tasks) in a MOOC development process. A way of "how-to-do" is the role of the Educational Design Pattern Language described in this section.

A design pattern "conveys the core of the solution to some relevant, recurring design problem" (Alexander et al., 1977). In the educational environment, "pedagogical design patterns have been introduced as a way to sketch and share good practices in teaching and learning; specifically, in the context of technology-enhanced learning (e-learning)" (May et al. 2016). Patterns can be related to each other and thus offer a toolkit of interrelated design solutions that can be applied to novel problems (Alexander et al. 1977; Goodyear, 2005; Goodyear and Retalis, 2010).

Moreover, patterns can be organized into coherent systems called pattern languages. In this context, an Educational Design Pattern Language for MOOCs has been under development, considering the activities described in the MOOCs life cycle process and the recurring solutions that solve common MOOC design and implementation problems. Figure 2 provides an overview of the Educational Design Patterns for MOOCs. A total of 49 patterns were firstly identified and grouped into eight categories: Exploration, Planning, Development, Delivery, Course Evaluation and Improvement, Mini Models of Active Learning Strategies, Patterns of Learning Evaluation and Feedback, and the general core of the Pedagogical Patterns orchestrated by Flipped Learning ideas.
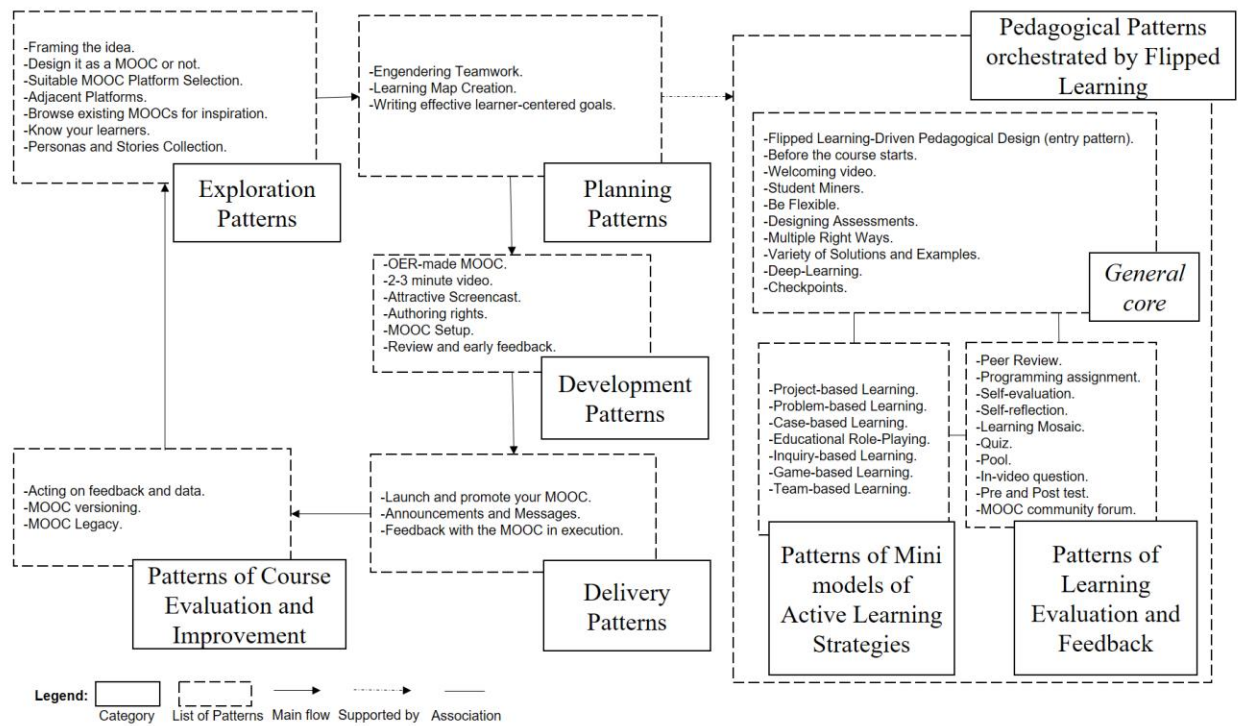
Figure 2 – Draft of the proposed Pattern Language.

A brief description of the related patterns, in the form of patlets (problem-solution pair), is presented below. It is important to notice that patterns are described using the COPPERPLATE GOTHIC LIGHT FONT while categories of patterns use the same font, but ARE UNDERLINED.

Exploration Patterns

During the Exploration phase of the MOOC life cycle, the MOOC team develops an understanding of the relevant teaching/learning challenges 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 learn. To simplify things, this could be done through a type of online pre-survey and can be sent to the target users by e-mail or can be available on the course's main page on the MOOC platform (before the course production starts). In this phase, it is also important to identify the organizational needs to define the business model as well as the delivery mode. Table 1 presents the set of patterns of the Exploration phase.

Table 1 – Set of patterns to support the Exploration phase.

PATTERN NAME	BRIEF DESCRIPTION (Problem-solution pair)
FRAMING THE IDEA	The first step is always the most complicated when starting a new project. **Therefore**, start planning your MOOC by considering personal, institutional, and technological aspects that can influence the MOOC design.
DESIGN IT AS A MOOC OR NOT	You need to understand the desirable characteristics of a MOOC before creating one, but you do not know how to start. Besides, there is no well-known definition for MOOCs and several authors have proposed design guidelines and principles for their development. Finding and reading all available content can be hard work. **Therefore**, a synthesis of characteristics and aspects, which must be considered in MOOCs, is listed in an instrument named "An artifact to support the validation of the adherence of MOOCs". The instrument is available online and can be used as a guide for practitioners mainly at the beginning of the MOOC development.
SUITABLE MOOC PLATFORM SELECTION	You may find that there are several ways and platforms for MOOC delivery. However, choosing the one that meets your needs is not an easy task. **Therefore**, identify your needs, familiarize yourself with MOOCs platforms available in your institution, or in the market, try to identify their main resources and functionalities that may interfere with your MOOC project, compare the different platforms and chose the one that fits best.
ADJACENT PLATFORMS [Adapted version from ADJACENT PLATFORMS by Warburton, 2015]	You want to make your MOOC rich and diverse, but you think that big MOOC providers, such as Coursera/FutureLearn/edx or even open platforms as open edX, Google Course Builder, and Tim Tec, are somewhat limited in scope as they try to provide a common foundation for all courses. **Therefore**, when additional functionality is required, the MOOC team needs to find appropriate tools and services to meet teaching and learning needs.
BROWSE EXISTING MOOCS FOR INSPIRATION	You want to propose a different, innovative, and catchy MOOC for students, but you do not know the current state of MOOC production in the domain being taught. **Therefore**, you should try to familiarize yourself with the related courses available on the top MOOCs platforms, compare taught concepts or learning outcomes with the definitions already made for your MOOC, and use the result you've obtained to refine your course idea (FRAMING THE IDEA).
KNOW YOUR LEARNERS [Similar to KNOW YOUR AUDIENCES by Warburton, 2015]	Delivering a successful product without understanding the target audience and their respective interests, needs, and desires, or without including users in the development process is quite challenging. In the MOOC context, the situation is harder because of the high number of people involved and the socio-economic-cultural and educational diversity of the audience. The course should be designed with who in mind? **Therefore**, an initial sketch of the personas (categories or groups of learners) that represent your target audience can be the first step. Try to find out more information and characteristics of these groups of learners. Start thinking about flexible strategies that address their needs and generate rich learning experiences. Try to build a course that is suitable for more than one group; despite knowing that pleasing everyone is always an impossible task. You can use PERSONAS AND STORIES COLLECTION to guide your design initially.
PERSONAS AND STORIES COLLECTION	Researching a MOOC's target audience is a difficult, expensive, and hard task. You and your MOOC team may encounter difficulties trying to find a simple and effective way to do that. **Therefore**, a web questionnaire based on this pattern "As (function, job title or user profile), I (should, want to, would like to) (action or goal), with the purpose of (value for personal or professional life)" can be a good strategy.

Planning Patterns

The Planning phase, in turn, serves to decide which stories have to be implemented first 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 Map, that is the main pedagogic structure used to identify interdisciplinary opportunities, and define

learning goals. A Learning Map (or Activities Map) is a well-known resource created during the Planning phase of an educational design process that contains the organization of classes and 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 that present an overview of the dynamics of the learning in the course. Table 2 presents the set of patterns that support the Planning phase.

Table 2 – General set of patterns to guide the Planning phase.

PATTERN NAME	BRIEF DESCRIPTION (Problem-solution pair)
ENGENDERING TEAMWORK [Adapted version from TEAM WORK by Warburton, 2015]	Building a MOOC is a team effort and it requires individuals with complementary skills and expertise. Training the 'MOOC team' to work collaboratively needs a plan that will get every party involved - academics, MOOC learning design team, librarian (for copyright clearance), media production team, legal services - all with a clear content and delivery strategy. **Therefore**, we have to make sure that there is a comprehensive plan that takes in the views of all parties. It is also important to consider each party and motivate collaboration and co-creation. LEARNING MAP CREATION can be used to support the team work.
LEARNING MAP CREATION	Creating a valuable course plan, or another type of documentation, that contributes to MOOC development enables interaction of the MOOC team members and facilitates discussions between them is not always easy. Although it is acknowledged that the course plan is a way to transfer ideas to a MOOC platform, serving as a common written language that can be easily understood by all the MOOC team members, sometimes members experience an initial reluctance to write and actively participate. **Therefore**, you can manage and consolidate the course planning through an artifact named Learning Map (also called Activity Map). The simple and visual nature of this concept forces you and the MOOC team to prepare clear, short, and meaningful information related to the course. This model of course planning is easy to fill and allows fast updates. WRITING EFFECTIVE LEARNER-CENTERED GOALS can be used to define learning goals. Moreover, the set of PEDAGOGICAL PATTERNS (ORCHESTRATED BY FLIPPED LEARNING IDEAS) can help you to organize the course pedagogical flow (mainly activities flow and types). Information identified from the EXPLORATION PATTERNS cannot be forgotten.
WRITING EFFECTIVE LEARNER-CENTERED GOALS [Adapted version from LEARNING OUTCOMES by Bergin et al., 2015a]	When planning a formal face-to-face, or virtual, course it is very common to start thinking about the content to be covered. This occurs for several reasons; for example, because we have to follow curricular programs defined by educational authorities, or because we use well-known textbooks as a reference. However, the MOOC context requires flexibility, activities diversity, and student-centered learning. **Therefore**, you should try to take your content topics and turn it into learner's outcomes. Start at the course level and then create specific learning outcomes (module level, lesson level, video level, among others). A way to define more active learning outcomes is to have in mind this sentence "by the end of this MOOC students will be able to do X, develop skill Y, etc.). You can also keep in mind Bloom's taxonomy when writing down learning outcomes to make them more explicit for the learner. MOOC students are more interested in applying and developing something new, so they are looking for higher-level knowledge and real learning. To conclude, ensure that learning outcomes are always explicit, so learners understand what they are supposed to be able to do or how they are expected to perform.

Pedagogical Patterns (orchestrated by Flipped Learning ideas)

With the LEARNING MAP CREATION pattern, a team can plan a course and visualize the expected learner's steps on the MOOC platform. However, organizing these steps or activities in a contextualized, innovative, creative, and motivating way depends greatly on the experience and background of the instructor and the team.

There is still one more thing missing to help them to improve the quality of the MOOC project. Thus, as a top-level pedagogical strategy, we consider the use of Flipped Learning ideas adapted to the virtual, open, and massive context. The point is considering Flipped Learning as a framework that is based on several theories which help the MOOC team to scrutinize diverse sets of characteristics required for MOOCs (DESIGN IT AS A MOOC OR NOT) and PATTERNS OF MINI MODELS OF ACTIVE LEARNING STRATEGIES. The issue of Flipped Learning as pedagogical strategy for MOOCs is elaborated further in (Fassbinder, Barbosa, and Magoulas, 2016; Fassbinder and Barbosa, 2015). Table 3 presents a set of pedagogical patterns to support the Planning phase. This pattern

selection is based on Flipped Learning ideas and fundamental pedagogical concepts adapted to the MOOC context to orchestrate the LEARNING MAP CREATION.

Table 3 – Set of pedagogical patterns based on Flipped Learning ideas.

PATTERN NAME	BRIEF DESCRIPTION (Problem-solution pair)
FLIPPED LEARNING-DRIVEN PEDAGOGICAL DESIGN (ENTRY PATTERN) [Similar idea to the entry pattern ASSESSMENT-DRIVEN COURSE DESIGN presented by Bergin et al., 2015a]	You are about to start the development of a new MOOC project and the main ideas underpinning the course are clear once you used the EXPLORATION PATTERNS. However, organizing learner's steps on the MOOC platform or activities in a contextualized, innovative, creative, and motivating way depends greatly on the experience and background of the instructor and the team. Besides, when there is little time, instructors tend to use traditional ways of teaching or simply transferring content from face-to-face environments to the virtual ones. **Therefore**, use Flipped Learning ideas applied to the context of MOOCs as drivers for developing the pedagogical strategy of your MOOC Learning Map to ensure that students' engagement and motivation are promoted.
BEFORE THE COURSE STARTS	You want to motivate active learning since the beginning of your MOOC. You already are using PATTERNS OF MINI MODELS OF ACTIVE LEARNING STRATEGIES to support the course itself. **Therefore**, you should define one or more activities that students must take before the course starts, in order to activate prior knowledge, prepare them to take a more active role, and create a connection with the rest of the course. This will also encourage the development of competences related to self-management or self-regulation of learning. Solutions include open ended questions, discussion forum, readings, creation of an initial project without using the concepts which will be covered in the course later. STUDENT MINERS is also an option. In addition, PRE TEST can also be used (PATTERNS OF LEARNING EVALUATION AND FEEDBACK).
WELCOMING VIDEO [Similar to INDUCTION by Warburton, 2015]	When launching a new course, or meeting students for the first time, one of the most important activities to plan is how to make a good start. A welcoming presentation has the potential to skew the students' opinions of the content being presented. As popular culture tells us, "the first impression is the last impression", and in the MOOC context this situation is amplified because of the diversity and openness. **Therefore**, to head this off, consider adding a welcoming video to the MOOC as well as the first thing a student should see when enrolling. Make it as compelling as you can. A welcoming video can also explain key aspects of the syllabus, class expectations, and instructors' personal biographical information. If the course is based on PATTERNS OF MINI MODELS OF ACTIVE LEARNING STRATEGIES, you should describe the main strategy used.
STUDENT MINERS [Adapted version from STUDENT MINERS by Köppe and Schalken-Pinkster, 2013]	You want to introduce a new concept BEFORE THE COURSE STARTS, or before a module starts, which is related in part to concepts the students already know. Just presenting a new concept makes it hard for students to associate this new knowledge to their existing knowledge and keeps them in an undesired passive role. **Therefore**, rather than introducing the idea yourself, introduce it through questions that are related to existing knowledge and lead towards the new concept. Let students give a variety of answers to these questions and lead the group through follow-up questions towards the new concept. Mine the new concept from all answers together with all students. You can provide comments or additional FEEDBACK WITH THE MOOC IN EXECUTION to deliver additional videos.
BE FLEXIBLE [Similar to BEND DON'T BREAK by Warburton, 2015]	Instructors want to deliver MOOCs and students want to learn through a MOOC because of many factors, but flexibility is a striking one. As an instructor, it is difficult to decide which parts of your MOOC can be flexible or fixed, or how to turn a MOOC more flexible without destroying the main properties (massivity, virtual, openness, and course). The delivery mode, platform functionalities, the MOOC subject area, for example, can interfere. **Therefore**, try to consider the core levels of flexibility, such as access, interaction with resources, allow different languages, flexible assessment tracks, self-paced learning, among others.
DESIGNING ASSESSMENTS	MOOC learners are voluntary learners, which try to balance time for learning with a full schedule of life, work, and family commitments. Is difficult for them to learn without any practice, by passively receiving information, and develop an understanding of what they almost know. It is also hard for them to maintain efforts alone. In the same time, it is very easy to give up on challenging activities. **Therefore**, include authentic, hands-on assessments based on real-world contexts. Apply different kinds of PATTERNS OF LEARNING EVALUATION AND FEEDBACK having your MOOC provider functionalities in mind. Assessments must be aligned with learning goals in a way that learners can demonstrate the skills they have learned (WRITING EFFECTIVE LEARNER-CENTERED GOALS). Include at least one summative assessment and several

	formative questions (i.e., Quiz, in-video question, Pool) per module. Include explanatory feedback that references relevant MOOC material, and design assessment activities considering your MOOC topic and the MOOC provider functionalities (e.g. use programming assessments for courses in computer science topic areas). Mainly in formative activities, each answer must explain why it is correct or not. Furthermore, Multiple Right Ways can guide the definition of questions' answers.
Multiple Right Ways [Adapted version from Multiple Right Ways by Bergin et al., 2015b]	You are assigning a task to students (forum, programming assignments, graded quizzes, practice quiz, peer review assignment, among others) using Patterns of Learning Evaluation and Feedback and you have to decide which answer is the right one. The task can be solved in multiple identifiable ways, i.e. they may be available multiple paths towards an appropriate solution. If you allow only one solution to be correct, then you are not fair to students who have found equivalent or even better alternatives. **Therefore**, allow multiple alternatives as correct answers. Additionally, use Variety of Solutions and Examples to exemplify possible ways to resolve a situation in the course.
Variety of solutions and examples	In online and massive courses, it is impossible to imagine that the instructor and the team can individually correct every student's answers. In addition, a question or activity hardly contains a single possible solution or a single application example (Multiple Right Ways). **Therefore**, you and your team need to think and develop a variety of possible solutions to the questions/activities used in the MOOC and make them available to students automatically, in the form of videos, figures, texts, codes, among others.
Deep-Learning [Similar to Productive MOOCs by Warburton, 2015]	Your MOOC's target audience is still passive, very focused on achieving a certificate at the end of the course, or they are novices in the MOOC context, but you want to encourage them to engage in authentic learning tasks for deep-learning, creation and knowledge sharing. **Therefore**, during your Learning Map Creation, try to contemplate activities that stimulate the development of high-level abilities, such as draw, build, program, criticize, experiment, moderate, compare, organize, among others. It is also related to Writing effective learner-centered goals. Moreover, you should include activities that encourage students to use digital technologies to create and share their own content (blog, videos, texts, etc.), and actions that motivate learners to discuss and learn more, even after the end of the course, so that they can act as agents of transformation in their contexts. You can also choose Patterns of Mini models of Active Learning Strategies.
Checkpoints [Adapted version from Checkpoints by Warburton, 2015]	In flexible and non-linear MOOCs, the interaction between participants is essential to the MOOC success. However, participants work on the learning activities at different pace, and sometimes even the order of undertaking activities differs, making it hard to synchronize the learning experiences between participants. Some participants diverge into independent explorations branching out of the MOOC activities. Sharing these could enhance the social learning experience, but at the same time, it makes synchronization even harder. **Therefore**, you should create regular "checkpoints", which allow participants to synchronize their own learning with the course flow and pace, catch up on the social vibe and follow the recent highlights. Such checkpoints could be synchronous events, recorded for those who cannot attend at the time. They can also be asynchronous events, such as forum posts or emails.

Patterns of Mini models of Active Learning Strategies

As the Planning phase is pedagogically driven by Flipped Learning ideas and fundamentals, and Flipped Learning is, in general, mainly focused on Active Learning Strategies, Table 4 summarizes a set of patterns to support the use of Active Learning Strategies in the MOOC context.

Table 4 – Set of patterns that summarizes models of Active Learning Strategies adapted to MOOC context.

PATTERN NAME	BRIEF DESCRIPTION (Problem-solution pair)
Project-Based Learning	You want to develop an authentic, flexible, and active MOOC using active learning strategies. You may know how to apply those strategies in a face-to-face context or even a formal virtual course, but you are unaware of any methods for adapting and applying these strategies in a massive and virtual context. **Therefore**, considering that such strategies are not new and there are existing patterns related to them, mainly from face-to-face environments, the presented adapted solutions describe steps to apply each of them considering their specificities. Specific solutions are omitted due to lack of space, but the patterns describe steps to apply the related active learning strategy but adapted to the MOOC context.
Problem-Based Learning	
Case-Based Learning	
Educational Role-Playing	
Inquiry-Based learning	
Game-Based Learning	
Team-Based Learning	

Patterns of Learning Evaluation and Feedback

It concerns different evaluation strategies that can be adapted to the MOOC context. Patterns summarized in Table 5 will be used during the Planning Phase in order to integrate the Learning Map Creation.

Table 5 – Set of patterns that summarizes evaluation strategies adapted to the MOOC context.

PATTERN NAME	BRIEF DESCRIPTION (Problem-solution pair)
Peer Review	You want to use different strategies to support learning evaluation and feedback in the context of online and massive course but you are unaware of techniques for doing that. What adaptations are needed for this context? **Therefore**, in general, you should try to make use of self-assessments based on clear objectives and criteria through rubrics or scales, which can be used by the students to evaluate their performance and knowledge development. Self-assessments can also support further reflection and help students to verify their understating of activities or content. Assessment activities should be authentic, based on real contexts. Moreover, the questions should be more divergent than convergent. That is, most of the questions can be answered in various ways, considering several options. If the MOOC platform allows, you should consider using videos with quizzes or simple internal questions that need to be answered before continuing with the course. Specific solutions were omitted due to lack of space, but the patterns describe steps to apply the related strategies but adapted to the MOOC context.
Programming Assignment	
Self-evaluation	
Self-reflection	
Learning Mosaic	
Quiz	
Pool	
In-video question	
Pre and Post test	
MOOC Community Forum	

Development Patterns

During the Development phase, learning activities and objects defined in the Planning phase are implemented and included in some MOOC provider (e.g. Coursera, edX, Udacity, MiríadaX, and Future Learn, among others) or a MOOC open platform (e.g. Tim Tec, Google Course Builder, and open edX). It is also time to design graded assessments that evaluate whether learners achieved the learning goals.

In this case, patterns that assist the MOOC team in preparing quality content with as little time and effort as possible are provided in Table 6. In general, they involve tasks related to (a) searching, recording and/or editing videos, (b) finding and preparing learning resources (readings, games, simulation, among others), (c) transferring the Learning Map and its related resources (videos, images, etc.) to the chosen MOOC platform.

Table 6 – Current set of patterns to support the MOOC development phase.

PATTERN NAME	BRIEF DESCRIPTION (Problem-solution pair)
OER-Made MOOC [Similar to Scaffolded MOOC by Warburton, 2015]	Many learning objects (readings, texts, videos, simulators, etc.) already exist about your MOOC subject matter. Creating new core course content can be a time-consuming process. **Therefore**, you should use already existing content in the form of Open Educational Resources (OERs) as a way to deliver content and support the students in achieving the learning outcomes (Writing effective learner-centered goals). This practice also helps to avoid copyright issues. Any additional type of contextualization or adaptation of those resources for your MOOC context can be delivered through textual messages, specific original videos, among other mechanisms.
2-3 Minute Video [Adapted version from Six Minute Video by Warburton, 2015]	You are aware that creating a full-length video of your lecture for online delivery is too demanding, from both a teaching and a student learning perspective. You cannot retain students' enthusiasm and passion for a full hour video, and you know that their attention will drop dramatically at various points across a long single recording. **Therefore**, you need to create smaller discrete episodes that you feel confident learners should be able to watch in their entirety. Current studies about MOOC videos indicate frequent changes in the size of videos for MOOCs. The smaller the better. In addition to learning and engagement aspects, technical issues (i.e. mobile devices, networking) also contribute to the adoption of even shorter videos. Thus, you should organize your video lecture material into sensible two or three-minute chunks. You can then be confident that students will stay focused throughout the duration of the video. This could be checked through the use of analytics within your MOOC platform.

ATTRACTIVE SCREENCAST [Adapted version from Rehearsal Script, Short & Sweet, Slower pace, Prepared text, Silent Narration, and Mouse Focus by Chen and Rabb, 2009]	You have decided that you are going to do a screencast on some topic. You have developed some ideas about what you would like to show. How do you transfer that into a screencast without missing the important topics or making the screencast confusing? **Therefore**, you should begin by making a written draft of your screencast script. The script should be detailed enough to know what it should include without missing the important topics. A good script has clear beginning and end. The beginning should tell the viewer what the screencast is all about. The end should have a strong summary of what the screencast has taught or accomplished. Another point is to set a time limit on how long the screencast should take. Make this a hard limit for yourself as the screencaster. This allows you to focus on the content at hand without spending too much time on the inconsequential parts of the screencast. As a rule of thumb, a screencast should not be longer than 5 minutes. Also you should make a deliberate effort to take about twice as long as you normally would to complete the task. This prevents you from moving your mouse too quickly. Another tip is to prepare the text snippets and other resources that you would use beforehand and store them into a file or auxiliary folder to avoid distractions, prevent recording typos and save time. Also, have in mind that silent screencasts tend to be less engaging. In addition, a good screencast should not contain any user interface elements that could distract the viewer from the main task at hand, for instance, e-mail alerts, blinking icons, the time on the menu bar or even a provocative desktop wallpaper. Don't forget to momentarily emphasize your mouse cursor to attract viewer's attention.
AUTHORING RIGHTS	Your MOOC is being prepared for online distribution under an agreement between a MOOC provider and your institution. **Therefore**, you should be aware of the relevant policies about intellectual property rights and open licensing. In addition, collaborative and partnership activities have clearly defined roles and responsibilities and operational agreements exist, where appropriate, incusing rights that instructors, guest presenters, and participants have to the content.
MOOC SETUP	You are ready to integrate resources into the MOOC platform you selected. **Therefore**, before launching the course, general settings must be defined, such as set a start and end date for the first session; define a MOOC logo (an image that represents the MOOC topic and adheres to copyright guidelines); define the MOOC topic (e.g. Software Engineering). Choose a title that accurately and precisely describes the MOOC content, differentiates the pedagogical strategy used, highlights relevant skills to be developed during the course, and is easy to be discovered by users via a web search. Also define its main language (e.g. Portuguese); specify hardware requirement (if needed); adjust time estimates for relevant items, so learners can plan their schedules and succeed in the MOOC; and arrange subtitle and course description translations to other languages. Furthermore, a landing page is the main contact of leaners who want to enroll in a MOOC. It describes the course in a specific way by highlighting outcomes, course content, prerequisites, instructors and related university. Spend some time designing a creative and effective landing page.
REVIEW AND EARLY FEEDBACK	You want to test new materials, teaching strategies, and creative assessments as well as improve your unlaunched MOOC before it reaches hundreds of learners. **Therefore**, you can apply several available review strategies and make changes and updates to the course based on feedback provided from reviewers. Some strategies include recruiting beta testers, and inviting a limited group of learners or staff to provide early feedback on MOOC materials in development.

Delivery Patterns

It concerns the course offered on the chosen MOOC platform, as well as activities to monitor and give feedback to the students. Table 7 presents some of the patterns that concern instructors and the MOOC team when providing feedback during the course delivery. Other patterns can also arise depending on the functionalities available in the MOOC platform, which allows for greater or lesser degree of communication between the instructor and the students.

Table 7 – Set of patterns to support MOOC delivery.

PATTERN NAME	BRIEF DESCRIPTION (Problem-solution pair)
LAUNCH AND PROMOTE YOUR MOOC	You are ready to launch and promote your MOOC. **Therefore**, you should have in mind that MOOCs are discovered by users through organic searches, but diverse communication channels must be used as marketing strategies to reach new or existing

	learners and retain them. It includes communicating the MOOC's launch through your Institution's website, promoting the MOOC at relevant conferences and events, and on social media, circulating emails and newsletters, and emailing current users of the MOOC provider, among others.
ANNOUNCEMENTS AND MESSAGES [Similar to DRUMBEAT by Warburton, 2015]	Faculty presence in virtual courses can encourage engagement and decrease dropout rates. However, due to the big number of students in MOOCs, maintaining your social presence as an instructor can be difficult. You are not able to provide individual and prompt answers to all learners. Correcting exercises manually is also challenging in this context. **Therefore**, different approaches can be used to alleviate this situation, such as welcoming and periodic e-mails; WELCOMING VIDEO; periodic forum posts; FEEDBACK WITH THE MOOC IN EXECUTION, among others.
FEEDBACK WITH THE MOOC IN EXECUTION	Your MOOC is delivered. However, you and your team noticed some problems or points that need clarification for the students. **Therefore**, you should provide generalized feedback during the MOOC delivery time in order to clarify points that have generated doubts and uncertainly among the learners. Add short videos (2-3 MINUTE VIDEO) on the MOOC platform, even if recorded informally, in your home or office. Such videos could contain Explanations for doubts and common queries; New cases with real life examples; Short lectures to clarify some concepts; Overview of the negative and positive points of the solutions identified in the answers already provided by the students; Use of examples and comparisons of resolutions already provided by students (but it is suggested to hide the names of those involved, making submission anonymous); Add these resources at the end of the lesson, in a separate section called "Additional Material, for those who require further explanation."

Patterns of Course Evaluation and Improvement

This concerns MOOC evaluation during and after its delivery. Pedagogy, learning objects quality, and other aspects can be evaluated by considering students and specialists' point of views.

Moreover, course updating concerns the analysis of findings from the MOOC final evaluation and the identification of future improvements and adaptations for future deliveries. The pattern MOOC LEGACY from Warburton (2015) proposes that "closing the course down alters its "open" status and so creating a legacy format for the course ameliorates this problem and facilitates expectation management for repeat sessions". Table 8 summarizes the main related patterns.

Table 8 – Set of patterns to support course evaluation and improvement.

PATTERN NAME	BRIEF DESCRIPTION (Problem-solution pair)
ACTING ON FEEDBACK AND DATA	MOOC providers have used different strategies to collect learners' data. You as an instructor may also use external forms to gather additional data. You know that once your MOOC ends, you can use feedback provided by the learners as well as additional data to improve your course and deepen your understanding of the learners' needs and how these are met by your course. However, this situation is not so clear yet. **Therefore**, you should analyze all forms of feedback provided by students and the data generated throughout the MOOC in order to collect information that can help you to improve the course. For example, demographic data (country of origin, gender, age, educational level, etc.) can help you understand the extent of the course and how diverse it was. Some platforms, such as Coursera, provide the number of likes and dislikes that learners have provided for course elements (video, assessments). Major changes in the overall design or content can lead to a new version of the course (MOOC VERSIONING).
MOOC VERSIONING	MOOC versions can have different statuses, such as original, archived, live, upcoming, new. Major changes that alter the course grading formula can be disruptive, and should be managed carefully. These may include adding, removing, or rearranging required assessments, adding or deleting weeks/modules, changing assessment from optional to compulsory, among others. **Therefore**, you should create a new version of your MOOC. All your current content could be transferred to the new version, so you would not need to start from scratch. When the new version is ready, you can release it in an upcoming session or leave the course archived (MOOC LEGACY).
MOOC LEGACY [Adapted version from MOOC LEGACY by Warburton, 2015]	Once a course ends, the material goes into hibernation. Closing the course down alters its "open" status. **Therefore**, creating a legacy format for the course ameliorates this problem to some extend and facilitates expectation management for repeat sessions. Export content from the MOOC and repurpose via alternative tools elsewhere. Make sure that the open archive is on a platform that is not dependent on regular support.

5. DESCRIBING TWO SPECIFIC PATTERNS

In this section, two specific patterns are detailed. The LEARNING MAP CREATION pattern was, in fact, adapted for the MOOC context, but has been common used in many learning design situations (i.e., formal virtual courses, learning resources, face-to-face courses, among others).

The pattern named FLIPPED LEARNING-DRIVEN PEDAGOGICAL DESIGN, in turn, can be considered as an entry point to a set of patterns that inform the pedagogical design of MOOCs having the ideas of Flipped Learning as a background.

Their description follows an adapted version of the Alexandrian template used by Alexander et al. (1977) and Avgeriou, Papalouros and Realis (2003), and includes the following fields:

Name – a unique identifier to distinguish the pattern.

One-liners - a brief explanation of the pattern.

Illustration – a representative case that helps practitioners in understanding the pattern's meaning.

Context – a brief explanation of the origins and the context of the problem in order to make it more comprehensible.

Problem – a brief description of the design problem.

Forces – are factors or issues influencing the adoption of a suitable solution to the problem.

Solution – a brief description of the solution proposed by the pattern that addresses the problem.

Action – a detailed and step-by-step description of the solution.

Example (additional field) – figures, hyperlinks, texts, and other sources to exemplify the final product someone gets when using the pattern. Examples are optional, in the proposed pattern language.

LEARNING MAP CREATION

Combining course planning, team support, and content overview in one place.
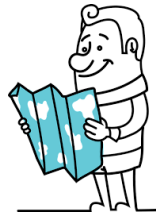
You and your MOOC team want to use an artifact that helps course planning and to formalize students' learning process and progression within the course. The artifact should also support instructional communication between team members (other instructors, tutors, web designers, learning designers, among others).

Problem

Creating a valuable course plan or another type of documentation which contributes to MOOC development and around which the MOOC team can interact and discuss is not a trivial task. Although the course plan is recognized as a way to transfer ideas to a MOOC platform and can act as a common course representation that can be easily understood by all MOOC team members, there is sometimes an initial reluctance to contribute to its writing and actively participate in this task.

Forces

- The Learning map should act as a roadmap for the instructor and his or her team when they are collaboratively planning the course, even if they are not fully familiar with the activity.
- A well-detailed artifact of this type reflects the sequence of steps and activities the students will take on the course platform.
- The Learning map artifact needs to be simple enough to allow continuous improvements of course planning and customizations to other platforms.
- It is common to make mistakes when you are not familiar with this activity, so your full attention is needed.

Solution

Manage and consolidate course planning by creating a Learning Map (also called Activity Map). As shown in Table 9, the simple nature and visual aspect of this concept forces you and the MOOC team to prepare clear, short, and meaningful information related to the course. This model of course plan is easy to complete and allows fast updating. WRITING EFFECTIVE LEARNER-CENTERED GOALS can be used to define learning goals. Moreover, the entry-pattern FLIPPED LEARNING-DRIVEN PEDAGOGICAL DESIGN can help you to organize the course pedagogical flow (mainly activities flow and types).

Table 9 – Example of a template to create a Learning Map.

Course	Title_of_course					
MOOC Provider	Name_of_provider					
Week number	**Class name**	**Description**	**Unit (or sub-classes)**	**Learning Outcomes (according to Bloom's Taxonomy)**	**Discussion Forum**	**Activities in the MOOC Platform**
…	…	…	…	…	…	…

Action

Start by adjusting the structure of the Learning Map. Some identification metadata are: course title, platform/provider name, and instructors (team). Metadata related to learning design include:

- Lesson number (or week number);
- Lesson title (or unit title);
- Learning outcomes to be achieved by the students, which can be defined through the Bloom's Taxonomy (Bloom, 1994; Anderson et al., 2001; Bloom et al., 1956);
- Sequence and information about the activities that learners must perform on the platform (reading, video, forum, evaluation, etc.);
- Sequence and information of the activities that must be performed on ADJACENT PLATFORMS.

New fields can be added, as the map structure may vary according to the platform or the teaching strategies adopted by the team.

Begin creating the Map with the definition of the learning outcomes to be achieved by the students. These represent knowledge, abilities and skills that instructors expect students to learn when they have completed the course.

After that, you should specify assessment activities that students must complete to demonstrate that they have met the learning outcomes set by the instructor. PATTERNS OF LEARNING EVALUATION AND FEEDBACK can be used.

Finally, you should define the teaching strategies and the sequence of learning activities.

Different teaching strategies may be used for each lesson, set of lessons, or a single strategy to guide the entire course. The entry-pattern FLIPPED LEARNING-DRIVEN PEDAGOGICAL DESIGN can help with the orchestration of teaching strategies and learning activities.

The LEARNING MAP CREATION can be continuously validated, either by experts, such as learning designers (or instructional designers), or representatives from the target audience. Also consider the use of the instrument named "Artifact to support the validation of MOOC projects" from the DESIGN IT AS A MOOC OR NOT , in order to verify your map.

Flipped Learning-Driven Pedagogical Design

Use Flipped Learning ideas to pedagogically orchestrate your MOOC Learning Map.

You are about to start the development of a new MOOC project through the Learning Map Creation and the main ideas underpinning the course are clear once you used the Exploration Patterns.

Problem

Organizing the steps that learners will perform on the MOOC platform or planning learning activities in a contextualized, innovative, creative, and motivating way depends greatly on the experience and background of the instructor and the team. It is difficult to develop deepen understanding of what you almost know, or even without any practice.

Forces

- Finding new ways of teaching and learning in the online, open and massive context is not an easy task.
- When there is little time and lack of specific guidance, the instructor tends to replicate in the MOOC context the same traditional (and sometime behaviorists) strategies used in face-to-face and virtual/formal environments.

Solution

As a top-level guidance, use Flipped Learning ideas applied to the context of MOOCs as drivers for developing the pedagogical strategy of your MOOC Learning Map (Learning Map Creation). The idea is to ensure that students engagement and motivation will be potentialized. Flipped Learning can be considered as a framework that is based on theories that help the MOOC team to apply several desirable characteristics for MOOCs (Design it as a MOOC or not).

Action

Design a Welcoming video to explain key aspects of the MOOC (pedagogical strategy, types of assessment, learning outcomes, among others). This video will be one of the first videos that students will watch. You can leave shooting for later, after having an overview of the MOOC project final version, but don't forget it!

Define one or more activities that students must perform Before the course starts, with the aim of triggering prior knowledge and promoting active student participation in the course. It is also a way to stimulate MOOC participants to develop self-regulated learning. You can also use Student Miners to introduce new concepts through questions that are related to existing knowledge and lead students towards the new concept.

Considering the structure of the main MOOC platform (Suitable MOOC Platform Selection), first adopt Patterns of mini models of Active learning strategies to support teaching and learning. For small courses, a single active strategy is suitable for the main course flow. This helps the instructor and the team when organizing

the sequence and types of activities that students should perform on the platform. Additionally, you should create connections between the activities Before the course starts and the course itself. Also you can use Patterns of Learning Evaluation and Feedback to verify if the students are on the right track.

Try to Be Flexible when thinking about the core levels of flexibility in your course. You can also use strategies to maintain the faculty presence in the course (Announcements and Messages). When assigning tasks to students, provide Multiple Right Ways as correct answers together with a Variety of Solutions and Examples to the questions/activities. Use Deep-Learning to include activities that encourage students to become more active in their own learning process. Create regular Checkpoints in order to offer to the participants good opportunities to synchronize their own learning with the course flow and pace, catch up on the social vibe, and follow the recent highlights.

Make use of a collaborative and social space. You can use the discussion forum or a similar environment in the platform as well as Adjacent Platforms that also serve as a learning community or digital repository where students and instructors can share digital learning resources. One or more Patterns of mini models of Active learning strategies can also be used to orchestrate this space.

By the end of the course, create new connections between the activities Before the course starts, the course itself, and the knowledge achieved during the course. Reuse Patterns of Learning Evaluation and Feedback, and also validate the course through Patterns Of Course Evaluation and IMPROVEMENT. Table 10 summarizes the main ideas and elements behind this pattern:

Table 10 – The pattern Flipped Learning-Driven Pedagogical Design summarized in a table format.

Before the MOOC (week 0)	MOOC (from week 1 up to the final week)	After the MOOC
✓ Welcoming video ✓ How the MOOC works ✓ Presentation ✓ Learner survey ✓ Pre-Test ✓ Self-regulation (initial strategy) ✓ Initial activity or question to trigger prior learning experiences and create a connection with the rest of the course.	✓ Use of Active Learning Strategies to guide activities and resources that can be performed by learners to achieve their learning goals. ✓ Learning evaluation and feedback ✓ Self-regulation (checking knowledge progression) ✓ Discussion forum/learning community	✓ Self-regulation (final update) ✓ Pos-test ✓ MOOC evaluation

6. CONCLUSION AND FUTURE WORK

In this paper, we presented an overview of an Educational Design Pattern Language to support instructors and the MOOC team when designing for learning in the context of Massive Open Online Courses. All the main patterns, in the form of patlets (problem-solution pair), were shortly described, and two specific patterns were analyzed. More patterns related to the Development, Delivery and Course Evaluation and Improvement phases need to be mined. Future works include the refinement and the inclusion of new potentially useful patterns and categories.

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