UNIVERSIDADE DE SÃO PAULO
Instituto de Ciências Matemáticas e de Computação

A contribution to the process of designing for learning in Massive Open Online Courses (MOOCs)

Aracele Garcia de Oliveira Fassbinder

Tese de Doutorado do Programa de Pós-Graduação em Ciências de Computação e Matemática Computacional (PPG-CCMC)

ICMC USP
SÃO CARLOS

SERVIÇO DE PÓS-GRADUAÇÃO DO ICMC-USP

Data de Depósito:

Assinatura:_________________________

Aracele Garcia de Oliveira Fassbinder

A contribution to the process of designing for learning in Massive Open Online Courses (MOOCs)

Doctoral dissertation submitted to the Institute of Mathematics and Computer Sciences – ICMC- USP, in partial fulfillment of the requirements for the degree of the Doctorate Program in Computer Science and Computational Mathematics. *FINAL VERSION*

Concentration Area: Computer Science and Computational Mathematics

Advisor: Prof. Dr. Ellen Francine Barbosa

USP – São Carlos
August 2018

Ficha catalográfica elaborada pela Biblioteca Prof. Achille Bassi
e Seção Técnica de Informática, ICMC/USP,
com os dados inseridos pelo(a) autor(a)

G216c Garcia de Oliveira Fassbinder, Aracele
A contribution to the process of designing for learning in Massive Open Online Courses (MOOCs) / Aracele Garcia de Oliveira Fassbinder; orientadora Ellen Francine Barbosa. -- São Carlos, 2018.
220 p.

Tese (Doutorado - Programa de Pós-Graduação em Ciências de Computação e Matemática Computacional) -- Instituto de Ciências Matemáticas e de Computação, Universidade de São Paulo, 2018.

1. Educação a Distância. 2. Aprendizagem. 3. Cursos Online Abertos e Massivos (MOOCs). 4. Projeto de Aprendizagem. 5. Engenharia de Software. I. Francine Barbosa, Ellen, orient. II. Título.

Bibliotecários responsáveis pela estrutura de catalogação da publicação de acordo com a AACR2:
Gláucia Maria Saia Cristianini - CRB - 8/4938
Juliana de Souza Moraes - CRB - 8/6176

Aracele Garcia de Oliveira Fassbinder

Uma contribuição ao processo de design de aprendizagem em Cursos Online Abertos e Massivos (MOOCs)

Tese apresentada ao Instituto de Ciências Matemáticas e de Computação - ICMC-USP, como parte dos requisitos para obtenção do título de Doutora em Ciências – Ciências de Computação e Matemática Computacional. *VERSÃO REVISADA*

Área de Concentração: Ciências de Computação e Matemática Computacional

Orientadora: Profa. Dra. Ellen Francine Barbosa

USP – São Carlos
Agosto de 2018

To my beloved parents.

ACKNOWLEDGMENTS

This PhD. work relied on the help and support of many individuals. Thus, my heartfelt thanks go to the following people who have been with me on this journey.

First thing, I thank God for being The light in my life and never let me down.

To my beloved husband, Marcelo Fassbinder, for your support, patience, and encouragement, since when we meet. Love you, unconditionally.

To my parents, Isabel and João Batista, for supporting me in all my personal and academic journeys. This one was a big one, that's true, and there you were…always praying for me.

To my dear advisor, Professor Ellen. I have no words to express how grateful I am for having you as my advisor. It's an honor and a great pleasure being your "academic daughter". Thank you for everything, truly.

My sincerely thanks to George Magoulas and the Birkbeck College, for having me during my internship in London. There I had such amazing experiences to improve this research and I myself, as a person. George was an incredible advisor. Thanks for the suggestions, meetings, ideas, the reviews in our papers, and for having me as an academic partner.

To Gisela, Marília, and Matrei, for sharing their time in London with me, for helping me with bureaucratic things in the city, and for listening me when I needed.

To my friends and "academic siblings" from CAEd and Labes (University of São Paulo), and London Knowledge Lab (Birkbeck College – University of London).

To my colleagues and students from the Federal Institute of Education, Science and Technology of the South of Minas Gerais (IFSULDEMINAS), for your support.

To CAPES, CNPq, and the IFSULDEMINAS, for your financial support.

At last but not least, to the University of São Paulo (USP) and the Institute of Mathematics and Computer Sciences (ICMC). I am very honored for being part of such important institution. A child's dream comes true today. Thank you for all the opportunities.

"Não é sobre chegar no topo do mundo e saber que venceu.

É sobre escalar e sentir que o caminho te fortaleceu..."

Trem-Bala, by Ana Vilela

RESUMO

FASSBINDER, A. G. O. **Uma contribuição ao processo de design de aprendizagem em Cursos Online Abertos e Massivos (MOOCs)**. 2018. 220p. Tese (Doutorado em Ciências – Ciências de Computação e Matemática Computacional) – Instituto de Ciências Matemáticas e de Computação, Universidade de São Paulo, São Carlos – SP, 2018.

Cursos Online Abertos e Massivos (MOOCs) possuem o potencial de abrir oportunidades educacionais e experiências de aprendizado para um público global, combinando os avanços tecnológicos recentes e a aprendizagem mediada pela tecnologia. Em geral, eles são considerados cursos virtuais que não exigem qualificações prévias para a entrada, podem ser acessados por qualquer pessoa e atraem um público diversificado, com uma variedade de experiências e qualificações profissionais. No entanto, equipes responsáveis por desenvolverem MOOCs (incluindo instrutores e projetistas de aprendizagem, entre outros) deparam-se com vários desafios ao projetar para a aprendizagem nesse contexto. Neste trabalho, duas lacunas principais são investigadas e abordadas: a falta de estratégias de projeto de aprendizagem bem definidas e validadas para apoiar os profissionais no desenvolvimento de MOOCs; e as limitações nos modelos de projeto pedagógico adotados, geralmente baseados em formatos tradicionais de sala de aula, tais como abordagens centradas no professor e a aprendizagem baseada em conteúdo. O objetivo deste trabalho é propor e validar uma estratégia de projeto de aprendizagem denominada *Learning Design Framework for* MOOCs (LDF4MOOCs), baseada em mecanismos de Engenharia de Software e procedimentos sistemáticos para garantir a padronização e a produtividade de todos os aspectos envolvidos no processo de desenvolvimento de MOOCs. LDF4MOOCs consiste em: (i) um processo do ciclo de vida para MOOCs, que descreve etapas fundamentais para planejar, oferecer e avaliar um MOOC; (ii) uma Linguagem de Padrões de Projeto Educacional para MOOCs, baseada em problemas e soluções recorrentes para resolver as principais atividades descritas no ciclo de vida; e (iii) recursos de apoio relacionados. LDF4MOOCs também é pedagogicamente informado pelas ideias de *Flipped Learning*, incluindo estratégias de aprendizagem ativa, aprendizado autorregulado, projeto baseado em competências, aprendizado centrado no aluno, entre outros. O *framework* e seus elementos foram validados internamente por meio de um estudo experimental, três estudos de caso e duas revisões por especialistas. Adicionalmente, um estudo de campo envolvendo educadores que usaram o LDF4MOOCs como uma guia para desenvolver seus MOOCs foi utilizado como método de validação externa. Os resultados obtidos indicam que LDF4MOOCs apresenta um impacto positivo no projeto de aprendizagem para MOOCs, sugerindo que tal estratégia pode ser efetivamente aplicada para apoiar e melhorar o desenvolvimento de MOOCs.

Keywords: Educação Virtual Aberta; Projeto de Aprendizagem; MOOCs; Aprendizagem mediada por tecnologias; Linguagem de Padrões; Flipped Learning.

ABSTRACT

FASSBINDER, A. G. O. **A contribution to the process of designing for learning in Massive Open Online Courses (MOOCs)**. 2018. 220p. Tese (Doutorado em Ciências – Ciências de Computação e Matemática Computacional) – Instituto de Ciências Matemáticas e de Computação, Universidade de São Paulo, São Carlos – SP, 2018.

Massive Open Online Courses (MOOCs) hold the potential to open up educational opportunities and learning experiences to a global audience by combining recent technological advances with technology-enhanced learning. In general, MOOCs are considered online courses that require no prior qualifications for entry, can be accessed by anyone, and attract a diverse audience from a variety of learning and professional backgrounds. However, MOOC teams (including instructors and learning designers, among others) face several challenges when designing for learning in this context. In this work, two main challenges are investigated and approached, namely the lack of well-defined and validated learning design strategies to support practitioners in the MOOC development, and the poor pedagogical design models adopted in MOOCs, which are generally based on traditional classroom formats, such as teacher-centered approaches and content-based learning. Thus, the purpose of this work is to propose a learning design strategy, named Learning Design Framework for MOOCs (LDF4MOOCs), which is grounded on Software Engineering mechanisms and systematic procedures to ensure the standardization and the productivity of all the aspects involved in the MOOC development process. LDF4MOOCs consists of: (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 life cycle; and (iii) the related supporting resources. LDF4MOOCs is also pedagogically informed by Flipped Learning ideas, including active learning strategies, self-regulated learning, competency-based design, learner-centered learning, among others. LDF4MOOCs and its elements were evaluated through an experimental study, three case studies, and two expert reviews as internal evaluation methods. Additionally, a field evaluation with educators using the framework as a guide to design their MOOCs was considered as an external evaluation method. The obtained results indicated that LDF4MOOCs has a positive impact on the design for learning in MOOCs, suggesting that our strategy can be effectively applied to support and enhance MOOC development.

Keywords: Open Online Education; Learning Design; MOOCs; Technology Enhanced Learning; Pattern Languages; Flipped Learning.

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

ADDIE	Analysis, Design, Development, Implementation, Evaluation
CAED	Applied Computing in Education Laboratory
CE	Criteria of Exclusion
CI	Criteria of Inclusion
CMS	Content Management System
EDR	Educational Design Research
FL	Flipped Learning
ICMC	Institute of Mathematics and Computer Sciences
IFSULDEMINAS	Federal Institute of Education, Science and Technology of South of Minas Gerais
LDF4MOOCs	Learning Design Framework for MOOCs
LMS	Learning Management System
MOOC	Massive Open Online Course
MOOEP	Massive Open Online Education Platform
OER	Open Educational Resource
OOE	Open Online Education
PBL	Problem-based Learning
PLoP	Conference on Pattern Language of Programs
SEE	Software Engineering Education
SLR	Systematic Literature Review
USP	University of São Paulo

CONTENTS

1 INTRODUCTION

Massive Open Online Courses (MOOCs) are an instance of the open and online education movement that over the last years have promoted a lot of discussion among the educational and technology communities (CONOLE, 2014a; MARGARYAN; BIANCO; LITTLEJOHN, 2015). In general, a MOOC is an online course with the option of free and open registration, an open curriculum, and open-ended outcomes (MCAULEY et al., 2010; ZHU; SARI; LEE, 2018). The term was firstly used by educational researchers, such as George Siemens, David Cormier, and Stephen Downes, as reference to the Connectivism and Connective Knowledge course and its successors, which were networks of distributed online resources, also named cMOOCs (DOWNES, 2008). Shortly after, a new classification for MOOCs, based on well-structured learning pathway resources centralized on platforms (e.g. Coursera[1], MiríadaX[2], edX[3], among others), was also defined (ZHU; SARI; LEE, 2018).

In recent years, MOOCs have gained public interest and attention as a form of open and online education that has the potential to bring forward many benefits and impact on education. For instance, they can serve as a driver of diversity in education (SCHOPHUIZEN et al., 2018); enhance students learning by encouraging and engaging them for lifelong learning (ARIMOTO, 2016, p. 44); create opportunities of transition to formal higher education or lifelong learning activities (SCHOPHUIZEN et al., 2018); promote a re-conceptualization of higher education through the use of online study (LANE; CAIRD; WELLER, 2014); enhance teachers' skills from developing Open Educational Resources (OERs) and adopting learner-centered pedagogical approaches and active learning strategies (ARIMOTO, 2016, p. 42).

Because of the potential of MOOCs, there is a rapidly growing interest from academic institutions and educators in designing and delivering this type of course. Typically, this is done through popular MOOC providers, such as Coursera, MiríadaX, and edX, or by adapting open

[1] coursera.org
[2] miriadax.net
[3] edx.org

platforms, such as Google Course Builder[4], open edX[5], and the Brazilian instance named Tim Tec[6], into existing organizational infrastructures.

Although there is a lot of potential of MOOCs for technology enhanced learning, there still are challenges related to their effectiveness, and widespread production and adoption. One of the challenges faced by MOOC teams (including instructors and learning designers) is that well-defined and validated strategies to support practitioners in the MOOC development are still under investigated, despite research efforts from the Learning Design, Computer Science, and Educational communities. As a result, practitioners and learners have experienced issues associated to teaching and learning in a massive, open and online environment. For example, the design of innovative and groundbreaking MOOCs has been a difficult task for practitioners, especially novices, since there is no definite standard about the desirable design characteristics of MOOC courses (SCHOPHUIZEN et al., 2018). A second challenge is that most of the existing MOOCs are still pedagogically based on traditional classroom formats, such as teacher-centered approaches and content-based learning, which are less effective as a means of learning in the MOOC context (FASSBINDER; DELAMARO; BARBOSA, 2014; ZHU; SARI; LEE, 2018).

Similarly to the software development, the design of MOOCs requires the use of appropriate mechanisms and systematic procedures to ensure the standardization and the productivity of all the aspects involved in the MOOC development process, and to meet the desired quality of the resultant materials. Thus, considering the challenges previously described, this Ph.D. work focuses on the development and validation of a learning design strategy for MOOCs, which is grounded on the perspective of Software Engineering fundamentals. Suh strategy is named *a Learning Design Framework for MOOCs* (LDF4MOOCs) and consists of: (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 life cycle; and (iii) related supporting resources. LDF4MOOCs is also pedagogically informed by Flipped Learning ideas (BERGMANN; SAMS, 2014; SAMS; BERGMANN, 2013).

[4] https://edu.google.com/openonline/course-builder/index.html
[5] https://open.edx.org/
[6] timtec.com.br/pt/instalacao-e-desenvolvimento

1.1 OBJECTIVES

This work is situated in the research line named Open and Online Education of the Applied Computing in Education Laboratory (CAEd[7]) at the University of São Paulo (ICMC-USP). Furthermore, it is an interdisciplinary theme that approaches a set of aspects related to Technology Enhanced Learning, Open Online Education, Learning Design, and Software Engineering concepts, all of them applied to the context of MOOCs.

Considering the context, motivation, and challenges previously presented, the main goal of this Ph.D. research is to investigate the development of MOOCs and propose suitable mechanisms that can be used to effectively support practitioners (e.g., instructors, learning designers, educational technologists, among others). Particularly, we intend to develop and validate a learning design strategy based on Software Engineering principles so that it can contribute to support MOOC teams when designing for learning in this context.

Based on this general question, the main objectives of this work are described as follows:

- **Investigate the development of MOOCs:** We aim to provide an overview of the current landscape and context where MOOCs emerged and have evolved. We also intent to find evidences that justify the creation of a learning design strategy for MOOCs. Thus, the goal is to verify if there is a lack of studies in these research area as well as to investigate the existing gaps for conducting new research.
- **Investigate learning design strategies for MOOCs.** The primary idea is to characterize how MOOCs have been designed by practitioners, including the strategies proposed and used to support their development. We also intend to characterize the main problems and barriers that MOOCs teams have faced when designing for learning in this context.
- **Investigate and propose a learning design strategy grounded on Software Engineering concepts.** We intend to investigate how appropriate Software Engineering mechanisms and systematic procedures can contribute to address the challenges and open issues in the MOOC design and enhance the standardization and productivity of the MOOC development process. Particularly, we intend to study and use patterns and pattern languages as mechanics to capture and encapsulate knowledge related to learning design.

[7] http://caed.icmc.usp.br/

- **Plan and conduct case studies on Software Engineering education.** We intent to perform case studies, mainly on Software Engineering education, in order to provide a better understanding of practices and challenges when developing MOOCs. The case studies also act as formative evaluation of the learning design strategy for MOOCs proposed in this work, i.e., the LDF4MOOCs framework. Such cases are also an opportunity to investigate teaching and learning in software engineering-based MOOCs and how they could be better pedagogically designed.
- **Evaluate and refine the proposed learning design strategy for MOOCs.** We intent to conduct internal and external evaluation methods in order to investigate the impact of using the proposed LDF4MOOCs framework to support MOOC practitioners' learning design practices and learners' outcomes.

1.2 RESEARCH DESIGN

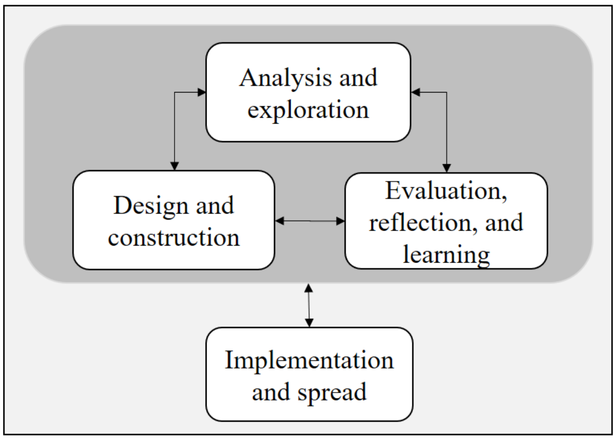
Among several existing research approaches (e.g. Action research, Ethnography, Evaluation Research, Correlational Research, Case Studies, Survey, Experiments, among others), as described in (NIEVEEN, 2009, p. 15), Educational Design Research (EDR) was the main strategy used to achieve the purpose of this work, previously defined.

According to Favier and Van Der Schee (2012, p. 2), there is not a single and well-known definition for Educational Design Research; some authors use the term as a common label for a family of related research approaches that treat design as a strategy for developing and refining theories on teaching and learning. Nieveen (2009, p. 17), in turn, defines this type of design research as the systematic analysis, design and evaluation of educational interventions with the dual aim of generating research-based solutions for complex problems in educational practice, and advancing our knowledge about the characteristics of these interventions and the processes of designing and developing them.

In a practical perspective, EDR is useful to support and guide studies that share the following characteristics: (i) address complex and relevant real-world educational problems; (ii) are involved in the design, development, and validation of research-based interventions for such problems, considering innovative design principles, products, and environments; and (iii) aim at designing and validating the intervention in a real-world setting. Furthermore, EDR has its roots on Action Research (SEIN et al., 2011) and Design Research (BARAB; SQUIRE, 2004).

EDR is an interactive and iterative process composed of the following general phases: context identification and problem analysis (analysis and exploration); development and refinement of interventions (design and construction); continuous evaluation, reflection and learning through all the phases (evaluation); final theorization through lessons learned, design principles, artifacts, among others (implementation and spread). Figure 1 illustrates an adapted version of EDR considering the ideas presented in (ANDERSON; SHATTUCK, 2012; MCKENNEY; REEVES, 2012; NIEVEEN, 2009).

Figure 1 - Educational Design Research process.



Source: Elaborated by the author.

Considering this background, EDR was chosen to guide this study and is mainly grounded on the literature presented by (REEVES, 2011; DE VILLIERS; HARPUR, 2013; AKKER et al., 2006; GRAVEMEIJER; COBB, 2006, pp. 104; ANDERSON; SHATTUCK, 2012; NIEVEEN, 2009).

In general, the context was firstly identified and the problem was defined by considering an analysis obtained from: (i) a systematic mapping on MOOCs (Chapter 2); (ii) a study on strategies to design for learning in MOOCs and their gaps (Chapter 3); and (iii) a review of the use of patterns and pattern languages for recording educational design experiences (Chapter 4).

The development and the refinement of LDF4MOOCs was divided into two main parts. Firstly, defining a MOOC life cycle process guided by Flipped-learning Teaching Method (BERGMANN; SAMS, 2014; BISHOP; VERLEGER, 2013), as a pedagogical approach, but considering MOOCs characteristics as specifics adaptations (Chapter 5). Secondly, this ‘blueprint’, the knowledge acquired from the previous steps, and our experience and insights from the development of three Software Engineering-based MOOCs and two meta-MOOCs acted as a base to discover patterns and the relationship between them, to define an Educational Design Pattern Language for MOOCs (Chapter 5).

LDF4MOOCs and its elements were evaluated through an experimental study, five case studies, and two experts review as internal evaluation methods. A field evaluation with educators using the framework as a guide to design their MOOCs was considered as an external evaluation method (Chapter 6).

According to McKenney and Reeves (2012), the implementation and spread of interventions occur in all phases, showing that interaction with practice is presented from the start, but increasing the scope over time. In this work, the involvement with learners and educational professionals from all over the world, such as learning designers, teachers, technologists, MOOC practitioners, among others, began early, and this involvement increased over time. In fact, deeper interactions of dissemination of the LDF4MOOCs framework firstly happened in the context of the Federal Institute of Education, Science and Technology of South of Minas Gerais (IFSULDEMINAS). However, practical and theoretical knowledge related to the MOOC development process has been shared through conference presentations, workshops, journal publications, and other media (Chapter 7). We also used a website[8] to share information about our project and allowed open access to the educational material produced along this research work (e.g., videos, artifacts, cases, among others).

1.3 THESIS OUTLINE

The remainder of this thesis is structured as follows. Chapter 2 presents a background on the fundamentals related to MOOCs. Chapter 3 explores approaches to design for learning in this context. Chapter 4 provides an overview of Patterns and Pattern Language foundations, which are essential to understand the framework proposed in this thesis. Chapter 5 introduces our proposal for designing and creating MOOCs, the LDF4MOOCs framework. Chapter 6 presents the methods used to validate LDF4MOOCs and its elements. Chapter 7 concludes with a summary of our thesis, main contributions, resulting publications, and outlines future work.

[8] caed.icmc.usp.br/mooc

2 FUNDAMENTALS OF MOOCS: A SYSTEMATIC STUDY

MOOCs are the main object of study in this thesis. Although related to well-known concepts, such as distance, virtual, and open education, they still are an emergent research field and literature specifically linked to them refers to relatively recent developments (SHAPIRO et al., 2017, p. 2). Therefore, a mapping study was performed in order to obtain an overview of their current landscape and context. Such study also provided the basis to conduct this work, particularly to enhance the body of knowledge on MOOCs.

This chapter covers the background on the development of MOOCs, the main challenges and open issues as well as theoretical, design, and technological aspects of MOOCs. From Section 2.1 to 2.4 we discuss the planning and the conduction of the systematic mapping study. In Section 2.5 we summarize and classify the primary studies retrieved. In Section 2.6 we discuss and analyze the main results obtained. In Section 2.7 we summarize the chapter.

2.1 CONTEXT OF THE STUDY

According to Kitchenham (2004), a Systematic Literature Review (SLR) is a trustworthy, rigorous and auditable means of identifying, aggregating, evaluating and interpreting about a topic or research question. This form of secondary study can be applied for many reasons, such as to summarize evidence concerning a topic, to identify gaps in current research, and to provide background positioning future research activities related to the topic of investigation, among other reasons. In addition, despite minor distinctions, there are two different types of SLRs: mapping studies and conventional SLRs. Mapping studies are used to find and classify the primary studies in a specific topic area, while conventional SLRs aggregate results related to a specific research question (KITCHENHAM et al., 2010). Since our primary goal is to obtain an overview of the MOOCs development landscape as well as identify the numbers and types of research undertaken, we consider mapping studies as a research strategy.

A first systematic mapping study was performed in 2014 and covered the available resources published until May 31^{th} 2014. The related results were presented during the XXV Brazilian Symposium on Computers in Education (SBIE) and are described in (FASSBINDER; DELAMARO; BARBOSA, 2014).

According to Felizardo (2016), despite the significant effort involved, whenever new evidence is published after the completion of a SLR, the SLR should be updated in order to preserve its value. Therefore, we also performed the updating of the study previously described, covering the period from June 2014 to early 2018. In this chapter, we contrast the updating with our previous results. Because of that, for convenience and to simplify reading, when necessary the original study will be referred as SLR1 and the updating as SLR2.

For the original study SLR1, we used the general SLR method as described in (BIOLCHINI et al., 2005), what involves activities of planning, execution, and summarization of the found results. The updating was grounded on (FELIZARDO et al., 2016) and (BIOLCHINI et al., 2005). The full protocol is available at http://goo.gl/DIIAF1.

Considering the intensive manual process of SLRs, the StArt[9] tool was used to support this work. It was selected by considering a study performed by (MARSHALL; BRERETON, 2013), which investigated tools to support SLRs in Software Engineering.

2.2 RESEARCH QUESTIONS

The rising of MOOCs made necessary the construction of a scientific foundation to support them. Thus, the main goal of the SLR1 and SLR2 is to review literature on MOOCs of the last ten years (2008-2018) with the intention to find answers for the following research questions (Table 1):

Table 1 – SLRs main research questions.

RQ1: How MOOCs have been defined or characterized?
RQ2: How MOOCs have been used or applied?
RQ3: Which approaches have been proposed and used to design MOOCs?
RQ4. What requirements have been investigated to develop or improve virtual environments for MOOCs?
RQ5. What are the main pedagogical and technological issues related to the development of MOOCs?

Source: Elaborated by the author.

2.3 THE SEARCH PROCESS

We reviewed papers written in English, published in scientific journals or conferences until early 2018, and available in six large electronic databases (i.e., data sources) identified as important to the educational and digital technologies field (DIESTE; GRIMÁN; JURISTO, 2009): IEEE Xplore, Scopus, ACM, Google Scholar, Web of Science, and Science Direct.

[9] http://lapes.dc.ufscar.br/tools/start_tool

All searches were based on title, keywords, and abstract. The searches took place between March and May 2014, for the first study; and October 2017 and January 2018, for the updating. The search process was validated considering the papers found by the original study.

Table 2 presents the general search string submitted to the electronic databases. When necessary, the string was adjusted for each database, according to their characteristics.

Table 2 - General search string.

(project OR design OR architecture OR development OR building OR experiment OR evaluation) AND (mooc OR moocs OR "massive open online course" OR "massive open online courses" OR "massively open online course" OR "massively open online courses")

Source: Elaborated by the author.

2.4 STUDIES SELECTION

The results obtained from the six different data sources were integrated. Then, we undertook an initial screening to select appropriate studies for inclusion in the review by considering the inclusion and exclusion criteria described in tables 3 and 4, respectively. Each paper could be included or excluded considering one or more related criteria. The inclusion criteria are related to the main research questions previously presented.

Table 3 – Inclusion Criteria (IC).

IC1. Studies focusing on the *proposition, characterization* or *definition* of MOOCs.
IC2. Studies reporting the *use* or *application* of MOOCs.
IC3. Studies describing *approaches* for the *design* of MOOCs.
IC4. Studies describing pedagogical and/or technical aspects/approaches for the development of *MOOC environments*.
IC5. Studies focusing on the *main pedagogical* and/or *technological gaps* in MOOCs.

Source: Elaborated by the author.

Table 4 – Exclusion Criteria (EC).

EC1. Studies that only mentioned the term MOOC, not fully addressing the concept.
EC2. Studies not written in English.
EC3. Duplicate studies.
EC4. Opinion studies.
EC5. Short papers (seven or less pages).
EC6. Papers not published in journals or conferences (i.e., book chapters, presentations).
EC7. Studies not available for download or reading.

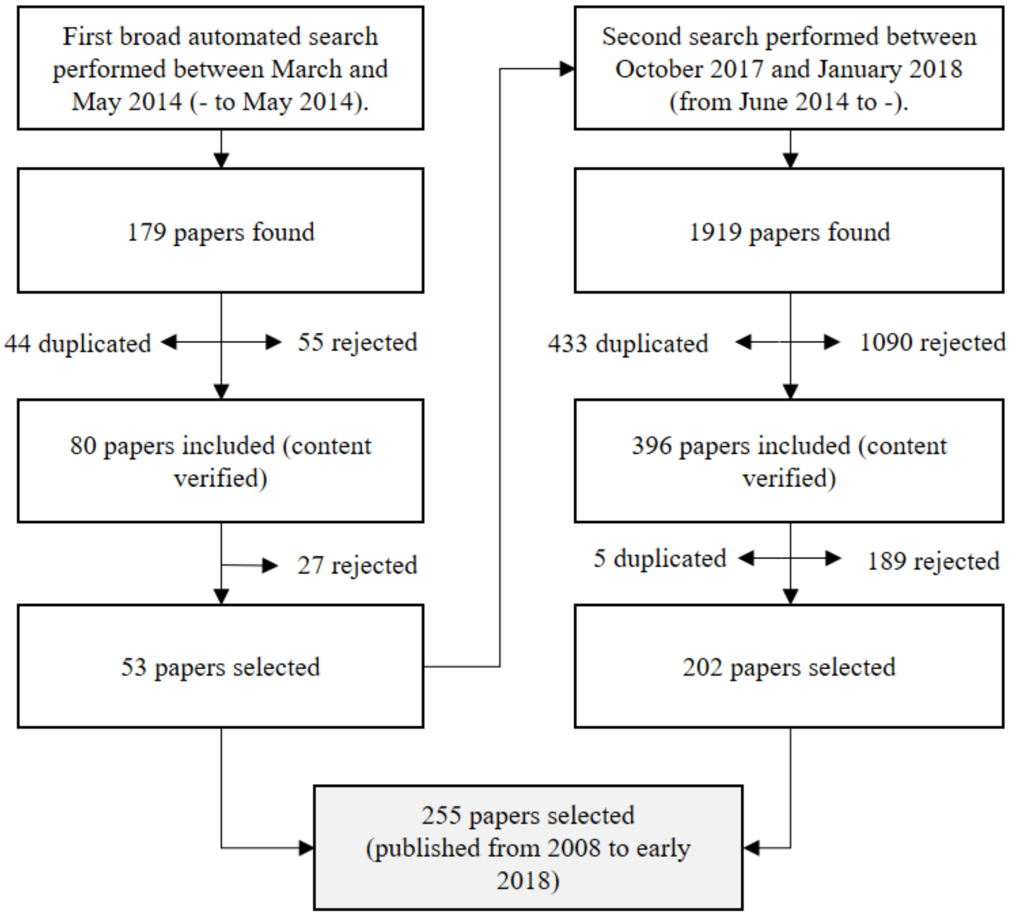
Source: Elaborated by the author.

2.5 SUMMARIZATION

Following the first application of the criteria, the full copies of the remaining papers were obtained, i.e., 80 (SLR1) and 396 (SLR2), and we performed a data extraction process.

Each paper was read and analyzed by one researcher and checked by a different one. Whenever there was disagreement about the classification of studies, the researchers talked and collaborated to arrive at an agreement. To assess quality, each paper received a score automatically adjusted by the StArt Tool. To each paper was also given a reading priority level ranging from “Very high” to “Very Low”. An overview of the study selection activity is summarized in Figure 2.

Figure 2 - Overview of the studies selection process.



Source: Elaborated by the author.

In addition to finding evidences to answer the research questions defined in Table 1, in this section we present a quantitative analysis that provide a starting point to understand the MOOC research trend.

Table 5 presents a summary of the included and excluded primary studies by database.

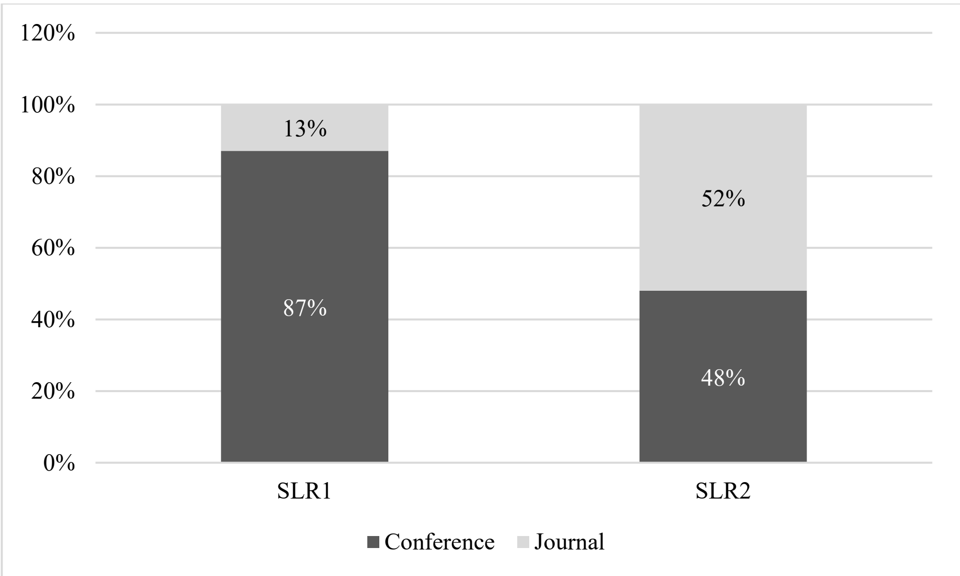
Table 5 - Total of papers by database in each step of the review and its updating.

	Results		Preliminary selection		Final selection			
Sources	SLR1	SLR2	SLR1	SLR2	SLR1	SLR2	Total	Ratio
IEEE Xplore	74	475	33	128	27	28	**55**	21.57%
Scopus	63	514	31	112	17	70	**87**	34.12%
ACM	21	551	10	42	4	35	**39**	15.29%
Google Scholar	10	120	2	41	1	32	**33**	12.94%
Web of Science	6	175	2	47	2	20	**22**	8.63%
Science Direct	5	84	2	26	2	17	**19**	7.45%
Total	**179**	**1919**	**80**	**396**	**53**	**202**	**255**	**100%**

Source: Elaborated by the author.

In general, considering the SLR1, around 87% of the studies identified were published in conferences and 13% in journals. However, SLR2 shows a different perspective, where the number of papers published in journals increased considerably, as highlighted by Figure 3.

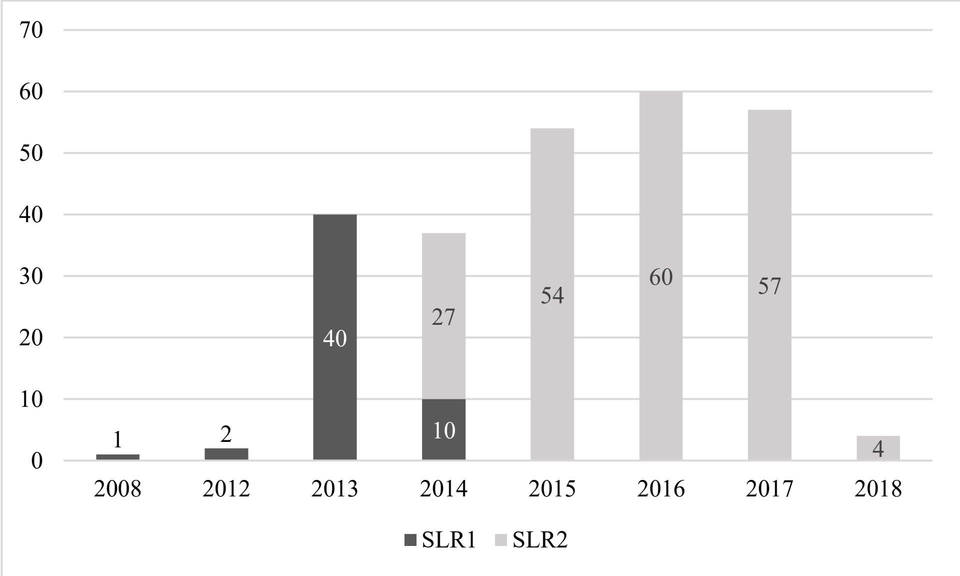
Figure 3 - Distribution of papers by publication media.



Source: Elaborated by the author.

Figure 4 shows the number of papers selected by year. It suggests that research on MOOCs increased substantially after 2014. This information is also supported by (BOZKURT; AKGÜN-ÖZBEK; ZAWACKI-RICHTER, 2017).

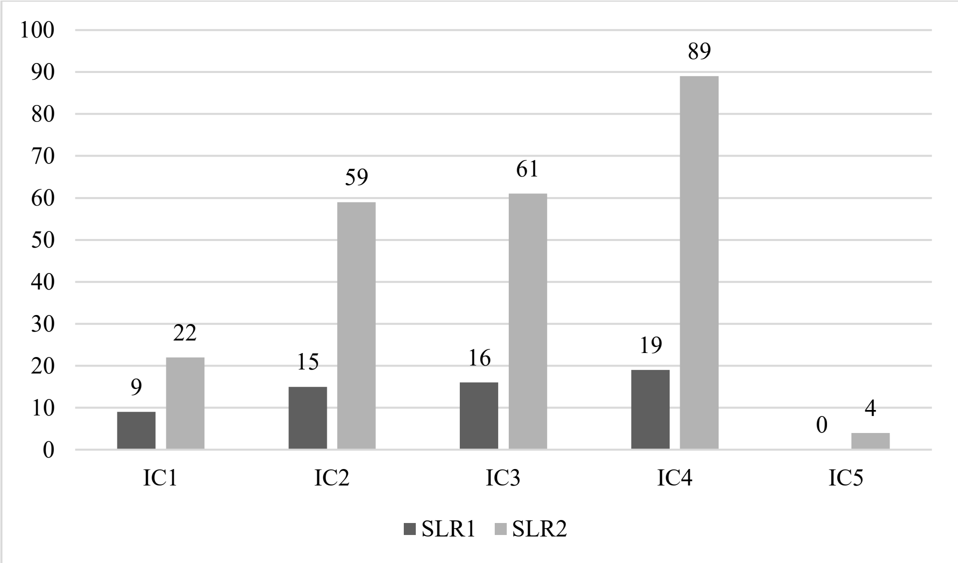
Figure 4 - Distribution of papers (by frequency) by year of publication.



Source: Elaborated by the author.

Regarding the distribution of papers by inclusion criteria (Table 3), Figure 5 highlights very small number of papers investigating aspects related to the definition and characterization of the term MOOC as well as its evolution and the exploration of new possibilities in terms of MOOC types (IC1). However, there is an expressive number of papers that explore and report experiences about the creation and use of MOOCs (IC2). The number of studies that investigate approaches to support the design of MOOCs also increased considerably (IC3). A drastic increase is also noticed regarding studies what focus on pedagogical or technical aspects/approaches for the development of MOOC environments (IC4). Studies focusing on the main pedagogical and/or technological gaps related to MOOCs are still under explored. Only 4 papers were identified and just in the SLR2. Some papers are related to more than one inclusion item.

Figure 5 - Distribution of papers by inclusion criteria.



Legend: IC1 (definition of MOOCs), IC2 (use or application), IC3 (approaches for the design of MOOCs), IC4 (MOOC environments), IC5 (gaps).

Source: Elaborated by the author.

2.6 DATA ANALYSIS AND RESULTS

The previous quantitative analysis gave us a starting point to understand the MOOC research trend. Going beyond, the following qualitative results provide us with more details and evidences to answer the research questions defined in Section 2.2.

2.6.1 RQ1: How MOOCs have been defined or characterized?

We organized this result in the following topics: (i) Definition and typology of MOOCs; (ii) MOOC principles and characteristics; and (iii) MOOCs and tools.

(i) Definition and typology of MOOCs.

There is a lack of a common definition of MOOCs. According to Yuan and Powell (2013), for example, they are an instance of the Open Education Movement (OEM) and, more specifically, an instance of the Open Online Education (OOE) that offers unlimited participation to students and open access via the web. Conole (2014a), in turn, defines a MOOC as an online course aimed at large-scale interactive participation and open access via the web. In addition to traditional course materials such as videos, readings, and problem sets, MOOCs provide interactive user forums that help build a community for the students, professors, and TAs (Teaching Assistants).

It is also possible to understand MOOCs by comparing their characteristics to e-learning courses, just like the Universitat Autonoma de Barcelona[10] does, as summarized in Table 6.

Table 6 - Differences between a formal online course and a MOOC.

e-learning course	MOOC
Use an e-learning platform (LMS) with a set number of functions and structure designed for interaction with lecturers.	A technological design that facilitates the dissemination of the activity of participants through one or more platforms.
Closed environment.	Open environment.
Access on payment of registration fee.	Free access.
Limited group.	Massive participation.
Majoritarian support of the teaching staff.	Support of the community and of the instructors.
Communication through debate forums.	Range of communication tools, including the use of social networks.
Evaluation and accreditation oriented.	Emphasis on learning process rather than evaluation and accreditation.
Offered at very specific moments of the academic year.	Depending on the platform, periodical sessions are open automatically.

Source: Universitat Autonoma de Barcelona.

However, the definition of the term MOOC is also related to the MOOC typology. Between 2008 and 2014, for example, there was a clear convergence of the analyzed papers in dividing them into cMOOCs and xMOOCs.

- **cMOOCs (Connectivism-based MOOCs).** The term MOOC has its foundations in 2007-2008 and was used by the educational activist and researcher named Dave Cormier[11] to describe the Connectivism and Connective Knowledge Course (CCK08) offered by Stephen Downes and George Siemens, from Manitoba (Canada). CCK08 is the successor to a series of previously successful Open Online Courses, as described in (FINI et al., 2008). According to Downes and Siemens, CCK08 was the first to incorporate open learning with distributed content, making it the first true MOOC[12]. The course and its successors, e.g. PLENK2010[13], led to the development of a MOOC model named cMOOC. They are also named networking-based courses and are based on open

[10] http://www.uab.cat/web/study/mooc/differences-between-a-mooc-and-an-online-course-1345668290741.html
[11] http://davecormier.com/edblog/2008/10/02/the-cck08-mooc-connectivism-course-14-way/
[12] https://sites.google.com/site/themoocguide/3-cck08---the-distributed-course
[13] http://connect.downes.ca/

teaching methods, open content, and make learners free to participate in various ways, such as using Blog, YouTube, Twitter, Facebook, and other social software systems.

- **xMOOCs (Extensionists MOOCs).** In 2012, the popularity of MOOCs increased considerably mainly due to new educational and technological MOOC experimental providers developed by American and European start-ups, such as Coursera[14], edX[15], Udacity[16], and FutureLearn[17], among others. 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.

However, analyzing the studies published in the subsequent years, new strategies have been used to classify MOOCs mainly regarding their learning design projects. In fact, the widespread discussion about the potential of MOOCs has stimulated universities and institutions to explore new types and models of MOOCs, as described following.

- **aMOOCs (Adaptive MOOCs).** They are adapted to the learner's individual learning preferences, and content is presented with differentiated learning strategies as well as intelligent feedback in real-time. An example is presented in (BLANCO; GARCÍA-PEÑALVO; SEIN-ECHALUCE, 2013).
- **mMOOCs (Mechanical MOOCs).** They are considered examples of non-formal, short-term education with no educational prerequisites. The mechanical attribute (first "m") refers to the absence of a teacher or tutor to offer or lead the course and the provision of peer learning (PONTI, 2014).
- **MOOEs (Massive Open Online Experiments).** They are grounded on the organic combination of MOOCs and experimental teaching by providing space and resources to make students complete experimental activities through the Internet (LI et al., 2016).
- **sdMOOCs (skill development MOOCs).** They are focused on skill development using free software, content created by experts and professionals, modular content and short term. Some providers, such as Udacity and Udemy, have some skill development courses, but the concept is defined by (SAHASRABUDHES; MAJUMDAR, 2016).
- **COOCs (Corporate MOOCs).** They are related to companies that create their own web environments to distribute courses connected to their sector and products. In

---

[14] http://www.coursera.org
[15] http://www.edx.org
[16] http://www.udacity.com
[17] http://www.futurelearn.com

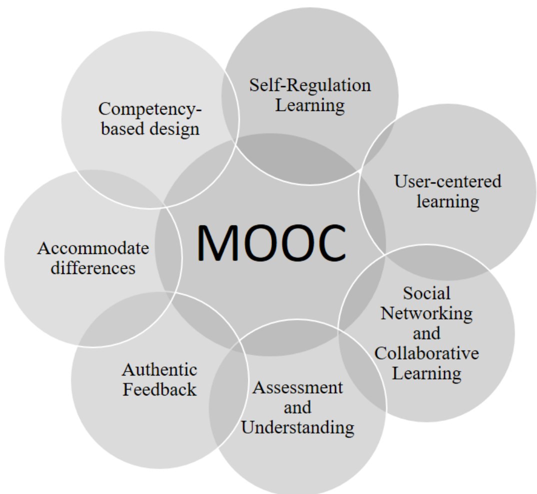
general, the main goals of a company that develop COOCs are client education, expertise certification, branding or sourcing, among others[18].

(ii) MOOC principles and characteristics.

Regarding MOOCs principles or their characteristics, the first MOOCs, i.e., cMOOCs, tried to motivate students' autonomy, diversity, openness, and interactivity (DOWNES, 2012). The *massiveness* of MOOCs is not only related to attract many people, but in the design elements that make educating many people possible (DOWNES, 2013). Thus, massiveness promotes an increasing diversity as well as interactions and connections among its participants. Such connections, in general, should be made without the mediation of a centralized authority (ANDERS, 2015). The *openness*, in turn, may have different meanings. Downes (2013), for instance, identified the common uses for the term open in MOOCs: open admission or removal of any academic barriers to participation in a course; free access to a resource by following the fundamentals of Open Educational Resources (OERs), among others.

Considering the previous types of MOOCs, in turn, there is a lack of a common definition of principles which can be used to define them, individually, and even guide their design. The main differences stem from the role of teachers and learners in the course, as well as the way in which the course is designed and how learning is achieved. Considering this systematic study, in Figure 6 we summarize key general design principles behind MOOCs, regardless of type. Such principles are further detailed in Chapter 5, where we describe an artifact based on them and aimed to support MOOCs development.

Figure 6 – Dimensions of design principles for MOOCs.



Source: Elaborated by the author.

[18] https://360learning.com/corporate-open-online-course

(iii) MOOCs and tools.

Considering tools and resources used to deliver MOOCs, three main approaches were identified:

- **MOOC Platforms.** Generally, they are open source platforms that can be installed and personalized by an individual or institution in order to deliver MOOCs using their own infrastructure (i.e., creating a MOOC Provider, as described next). It is also named Massive Open Online Education Platform (MOOEP). The main MOOC Platforms identified during our study are: (i) Google Course Builder[19], (ii) open edX[20], and (iii) the Brazilian representative Tim Tec[21].
- **MOOC Providers.** They correspond to any environment that provides the necessary tools for institutions or individuals that want to deliver MOOCs using third-party infrastructure. They are also referred as MOOC service or MOOC Hosting Service. Some of them are provided by private institutions, universities, schools, among others. Furthermore, in general, a contract of use is necessary (e.g., Coursera and MiríadaX). The main MOOC providers identified are summarized in Table 7.

Table 7 - Examples of MOOC Providers.

MOOC Providers	Website	Origin
Coursera	https://www.coursera.org/	USA
MiríadaX	https://miriadax.net/	Spain
Udacity	https://udacity.com/	USA
NovoEd	https://novoed.com/	USA
edX	https://www.edx.org	USA
Future Learn	https://www.futurelearn.com/	United Kingdom
Iversity	https://iversity.org	Germany
openHPI	https://open.hpi.de/	Germany

Source: Elaborated by the author.

- **Institutions and Universities' Providers.** Since the rising of MOOCs, in 2012, several institutions and universities have started to offer a range of MOOCs using their own technological infrastructure, as highlighted by (SMITH et al., 2017). Some of them use several tools or MOOC platforms to build their own MOOC provider, which aggregates

[19] https://edu.google.com/openonline/course-builder/index.html
[20] https://open.edx.org/
[21] http://timtec.com.br/pt/funcionalidades/

open source resources but requires a lot of knowledge and integration among the components. For example, Meinel, Totschnig and Willems (2013) present openHPI[22] based on open source projects, such as Rails, Bootstrap, EmberJS, RSpec, Grape, jQuery, and OmniAuth. Others use Learning Management System (LMS) or Content Management System (CMS), such as Moodle and Drupal (SANTOS; COSTA; APARICIO, 2013), which may be perceived as the closest option for instructors who want to start experimenting MOOCs. However, this strategy has limitations, including philosophy matters and adequacy to the massive approach. Table 8 summarizes some related examples.

Table 8 - Examples of Institutions' providers.

Institution	Website	Geographic main Location
openHPI	https://open.hpi.de/	Germany
IFSULDEMINAS	mooc.ifsuldeminas.edu.br	Brazil
openSAP	https://open.sap.com	Germany
QUT Open Online Learning	https://moocs.qut.edu.au/	Australia

Source: Elaborated by the author

2.6.2 RQ2: How MOOCs have been used or applied?

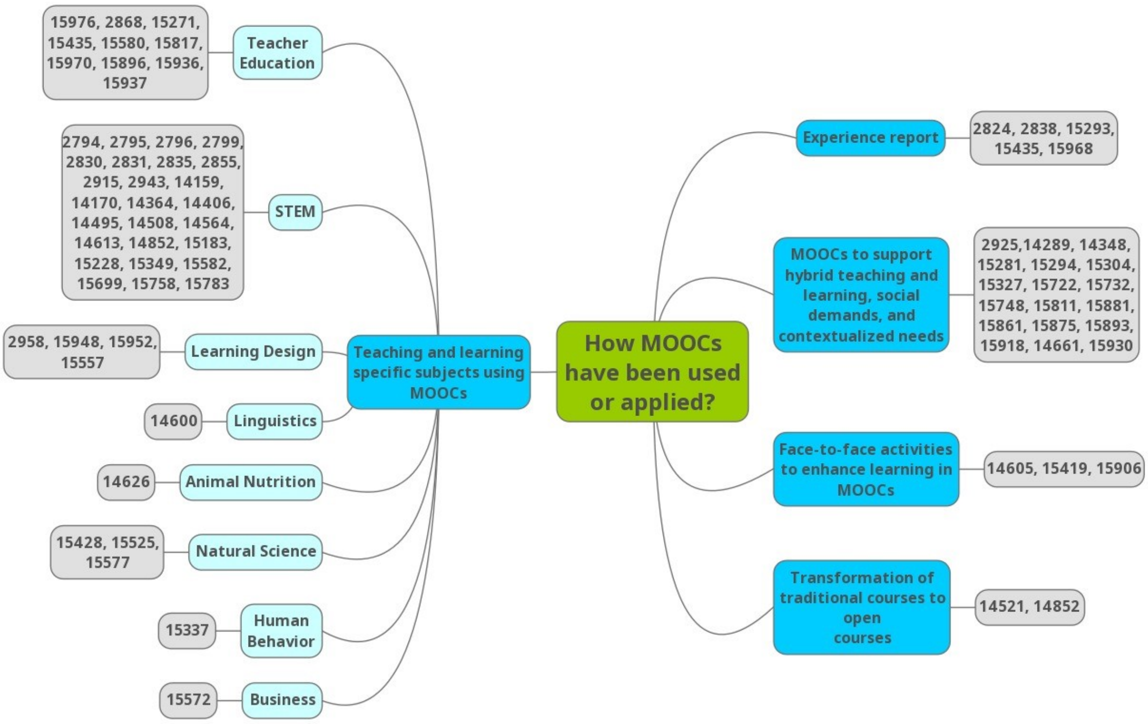
Figure 7 summarizes the potential applications of MOOCs identified during our mapping study. We classified each related paper into one of five categories according to its usage purpose, as described following.

- **Investigation on teaching specific subjects using MOOCs:** studies that explore design principles for MOOCs in specific contexts, such as Teacher Education, STEM, Learning Design, Linguistics, Animal Nutrition, Natural Science, Human Behavior, and Business. Such exploration approaches content adaptation, pedagogical strategies, assessment practices, metrics of success, challenges and needed adaptations in platforms in order to support teaching and learning in the specific field, among others.
- **Experience report:** papers that report experiences of developing MOOCs.
- **Use of MOOCs to support hybrid teaching and learning, social demands, and contextualized needs:** papers that describe MOOC design, technological means, and lessons learned from using MOOCs to support face-to-face courses.

[22] https://open.hpi.de/

- **Face-to-face activities to enhance learning in MOOCs:** studies reporting the facilitation process, influential factors, students perceived gains and other considerations about attending face-to-face study groups, offline meetups, MOOC camps, and other face-to-face activities to enhance students' motivation and engagement in MOOCs.
- **Transformation of traditional courses to open courses:** studies that present adaptations of face-to-face courses or other types of open courses to MOOCs. They describe interventions, impressions, evaluation data, among others.

Figure 7 - Examples of use and application of MOOCs grouped by categories and paper IDs[23].



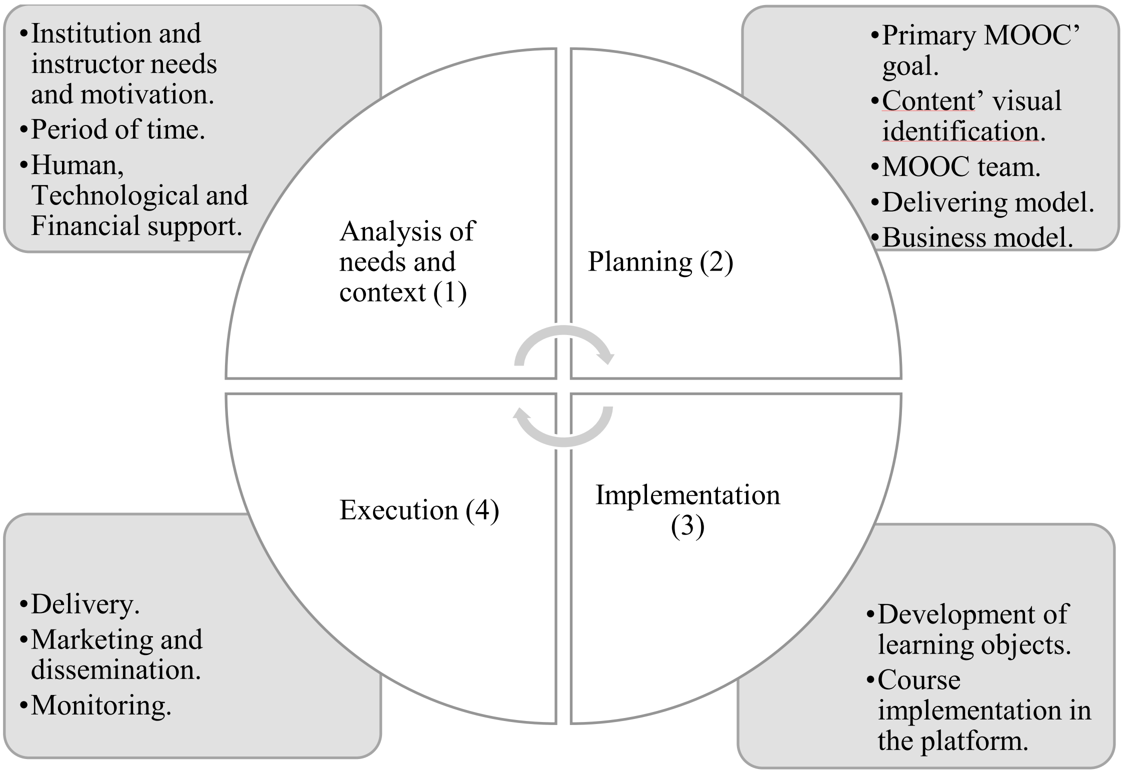
Source: Elaborated by the author.

2.6.3 RQ3. Which approaches have been proposed and used to design MOOCs?

In general, papers that described the development of MOOCs were mainly guided by four sets of activities: (i) Analysis of needs and context; (ii) Planning; (iii) Implementation; and (iv) Execution. Evaluation strategies could also be observed for all the sets. Figure 8 illustrates a generic MOOC development process proposed from the evidences identified during the original systematic mapping study (SLR1).

[23] The list of paper IDs is available at http://bit.ly/2IpLiR3.

Figure 8 - An initial generic process to develop MOOCs, identified through SLR1.



Source: Elaborated by the author. Adapted from (FASSBINDER; DELAMARO; BARBOSA, 2014).

Such process encompasses few design characteristics specifics for MOOC. The process was later refined and improved, and its current version is presented in Section 5.2, which details the MOOC Life Cycle Process also proposed in this thesis.

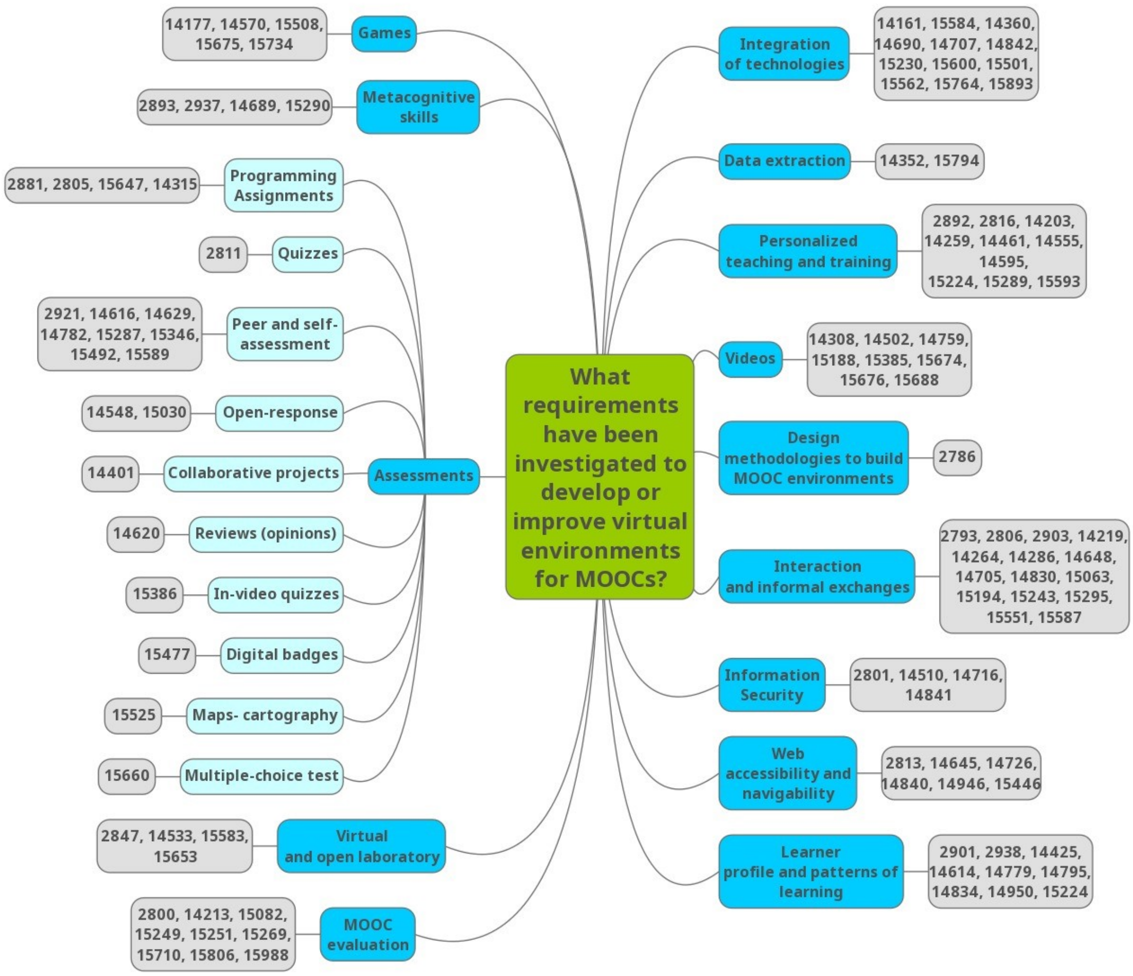
Regarding the use of strategies for MOOC design, three groups of strategies were identified: (i) specific approaches for MOOCs; (ii) traditional approaches applied for the MOOC context (i.e., strategies used in other contexts, such as face-to-face and formal virtual courses adapted or reused for the MOOC development); and (iii) general design guidelines proposed to design MOOCs (i.e., design guidelines captured from reviews, lessons learned, among others). As the main contribution of this thesis is LDF4MOOCs, i.e., an approach to support the design for learning in MOOCs, Chapter 3 provides a detailed explanation on this specific topic.

2.6.4 RQ4. What requirements have been investigated to develop or improve virtual environments for MOOCs?

The rise of MOOCs made necessary the development of mechanisms, tools, and digital techniques that automatically support different types of assignments (e.g., programming, writing, pair assessment), self-regulated learning approaches (e.g., Learning Mosaic

(FASSBINDER; BARBOSA, 2017)), active learning methodologies (e.g., Role-Playing, Project-based Learning), among others. Figure 9 summarizes topics or requirements that have received attention, mainly from the Computer Science and Software Engineering communities, in order to enhance MOOC platforms, providers, and related services.

Figure 9 - Topics investigated and developed under the viewpoint of computational aspects[24].



Source: Elaborated by the author.

- **Design methodologies.** Studies that present educational-oriented approaches for building personalized e-learning environments involving interdisciplinary teams of software developers and domain experts.
- **Assessments**. Papers that discuss improvement and also the development of different tools and functionalities to support generic and specific automatic

[24] The list of paper IDs is available at http://bit.ly/2IpLiR3.

assessment in different fields, such as programming assignments, quizzes, peer and self-assessment, among others.

- **Personalized teaching and training**. Solutions to support the generation of specific feedback for student mistakes, teaching materials, assessment, teaching methodology, learning dashboards, predicting the next page to be accessed, among others.
- **Metacognitive skills.** Papers that present implementation strategies to support students in the development of metacognitive skills, such as time management, monitoring of student attention, social comparison, among others.
- **Interaction and informal exchanges.** Strategies to boost participation, communication, and collaboration between students through forums, formation of learning groups as well as social presence of MOOC instructors. The main computational strategies applied are learning analytics, reputation system in forums, dynamic group formation, and deep neural network.
- **MOOC evaluation.** Studies that present approaches to enhance learning as well as course planning, development, and mainly evaluation through analysis of the available data. The main computational strategies considered are extraction of semantic data, machine learning, learning analytics, and fuzzy evaluation.
- **Information Security.** Papers that approach techniques to improve user authentication, being related to credentials recognition or biometric verification.
- **Virtual and open laboratory.** Papers that approach strategies regarding the creation and validation of massively-scalable laboratories or Massive Open Online Laboratories (MOOLs).
- **Web accessibility and navigability.** Papers that bring opportunities to understand and improve MOOC access for all, and mainly by the elderly and people with disabilities.
- **Learner profile and patterns of learning.** Studies that investigate strategies to identify leaners' profile, behavior, learning styles, use of ontology for modelling emotions, patterns of interaction with videos, assessment, and learning objects in order to personalize content, feedback, predict drop-out, among other needs. In addition, the computation techniques applied are learning analytics, ontology, and machine learning.

- **Integration of technologies.** Studies that report the use of adjacent tools to deliver MOOCs or to support the current MOOC platform in use, such as cloud services, social media, and OERs.
- **Games.** Use of gamified elements and serious games to support teaching and learning in MOOCs.
- **Video**. Studies that propose techniques to optimize learning by video.
- **Data extraction.** Studies that investigate ways to support data extraction and linked data from databases related to MOOCs. Such data can support research and experimentation in the field.

2.6.5 RQ5. What are the main pedagogical and technological issues related to the development of MOOCs?

The main challenges found in the SLR1 and SLR2 were related to the lack of information or guidelines that help instructors to understand the necessary mechanisms to create a MOOC, including technological, pedagogical, human, and financial issues. As a result, in general, most of the existing courses are still based on traditional classroom formats (FASSBINDER; DELAMARO; BARBOSA, 2014). Findings presented in Toven-Lindsey, Rhoads and (2015, p. 5), for example, suggest that the range of pedagogical practices currently used in MOOCs tends toward an objectivist-individual, instructional approach that relies on the assumption of a single objective reality, and focuses on the transmission of knowledge. Joksimović et al. (2018) also support this idea and states that the technical transition to learning at scale resulted in a need for existing pedagogical models to move beyond mere transmission of teacher-produced content.

Furthermore, despite the MOOCs popularity, practical guidelines for learning design in the MOOC context are under explored, leaving many instructors and educational technologists to rely on their own experiences when developing MOOCs (FASSBINDER et al., 2016). Margaryan, Bianco and LittleJohn (2015), for instance, examined the learning design quality of 76 MOOCs and found that while most MOOCs are well-packaged and well-organized, the learning design quality is low. Ross et al. (2014), in turn, argued that gaps in the process of designing for learning in MOOCs leave students, designers, and teachers with unrealistic expectations about what means to teach and learn at scale. Furthermore, regardless the popular adoption of MOOCs, many researchers agree that more research and experimentation about the design of MOOCs is required, such as (MCAULEY et al., 2010), (ALARIO-HOYOS et al., 2014), and (TOVEN-LINDSEY; RHOADS; LOZANO, 2015).

Lee et al. (2016) also argue about the difficult to find studies that propose a design model that considers practicality and prescription to give guidance to learning designers and instructors when designing MOOC. In addition, existing learning design approaches face some limitations and do not focus on the entire design process. Such context indicates that there is still room for improvement regarding the design and development of MOOCs; such gap is approached by this thesis.

2.7 SUMMARY

This chapter provided a general picture of the main aspects related to the design and development of MOOCs. The findings are grounded on two systematic literature reviews conducted as systematic mappings, being the original in early 2014 and its updating in early 2018. They focused mainly on the history, evolution, definition, classification and open issues related to the design and development of MOOCs and virtual environments.

The results obtained from the systematic mappings provided the basis to develop this thesis and to enhance the body of knowledge on MOOCs. In general, it was possible to identify the main problems and barriers faced by practitioners when designing MOOCs, such as lack of well-defined and validated strategies to support MOOCs development, and poor pedagogical design models of MOOCs.

Our proposal to minimize such specific gaps consists of a learning design strategy named LD4MOOCs. LDF4MOOCs is grounded on Software Engineering principles and is also pedagogically informed by Flipped Learning ideas, as described in Chapter 5.

In order to better understand the scenario of learning design strategies for MOOCs, in the next chapter we expanded the findings related to the systematic mappings research question number 3, *RQ3. Which approaches have been proposed and used to design MOOCs?*, and broadly discuss the main strategies to design for learning in this context.

3 DESIGNING MASSIVE OPEN ONLINE COURSES

The rapid growing interest of institutions and educators in designing and delivering MOOCs, either using popular providers or adapting open platforms to their own infrastructure, has revealed gaps that need to be further investigated. As previously highlighted, some of the main open issues are related to the lack of specific learning design approaches that support practitioners when developing MOOCs. There is also a need for incorporating more creative and empowering categories of pedagogical strategies for open online learning.

In this work, fundamentals of learning design are mainly grounded on (KOPER; TATTERSALL, 2005) and The Larnaca Declaration on Learning Design (DALZIEL et al., 2013, 2016). For Dalziel et al. (2013, 2016), Learning Design (capitalized) is used as reference to the field of Learning Design. According to Koper and Tattersall (2005), the term is also used to describe the human activity of designing units of learning, learning activities or learning environments. It 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. There are several ways to capture and encapsulate knowledge related to learning design. For example, theories consisting in a set of design principles; identification of best practices in teaching and learning; and capturing the knowledge in educational design patterns, which is the main focus of this thesis. Such ways are named learning design approaches or strategies, but can also have specific names, such as lesson plan, course scripts, and learning design frameworks. Furthermore, the term “Instructional Design” can be used as a synonymy for Learning Design, but some authors highlight they have a slightly different meaning[25,26].

Thus, to advance the understanding of how instructors are designing learning experiences, and also to find ways to improve the current practice of MOOCs development, in this chapter we present the current landscape of strategies used to design for learning in MOOCs.

In Section 3.1, the main strategies identified during the systematic review process characterized in Chapter 2 are described and analyzed. In addition to the review, we also performed a data triangulation (JICK, 1979; THURMOND, 2001) using a survey with instructors who have developed and delivered MOOCs; the idea is to confirm the strategies

[25] https://www.researchgate.net/post/Instructional_Design_versus_Learning_Design-Whats_the_difference
[26] https://www.smartsparrow.com/2016/07/12/why-we-prefer-learning-design/

they have used to design MOOCs and the main challenges they have faced. The survey is detailed in Section 3.2. In Section 3.3 we present a study on essential learning design requirements for MOOC projects. In Section 3.4 we summarize the main points of the chapter.

3.1 APPROACHES TO DESIGN FOR LEARNING IN MOOCS

The results retrieved for *RQ3. Which approaches have been proposed and used to design MOOCs?*, in Chapter 2, gave us an initial overview of the classification of design strategies for MOOCs. We categorized them into three main groups: (i) specific approaches for MOOCs; (ii) general approaches applied for the MOOC context (i.e., strategies used in other contexts, such as face-to-face and traditional distance learning, but adapted or reused for the MOOCs development); (iii) general design principles proposed to design MOOCs (i.e., design guidelines captured from reviews, lessons learned, etc.); and (iv) guidelines proposed by MOOC providers and educational institutions. The main approaches are summarized next.

3.1.1 Specific approaches for MOOCs

Table 9 summarizes approaches specifically created to support practitioners when designing for learning in the MOOC context.

Table 9 – Specific approaches to develop MOOCs and their validation strategies.

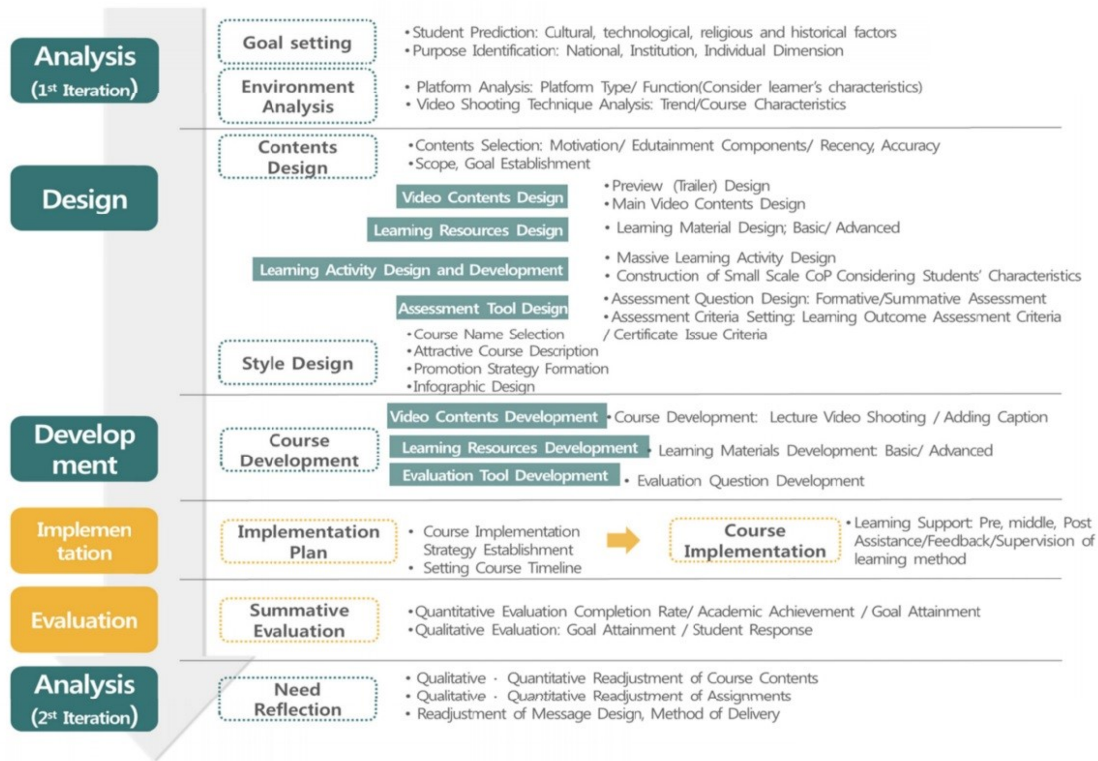
Approaches	Results	Construction and validation strategies
(LEE et al., 2016)	A MOOC Design Model in the form of a figure with course development procedures and activities.	Internal Validation (instructional designers, MOOC experts); External Validation (field test: interviews and questionnaire of teachers and learners).
(WARBURTON; MOR, 2015)	A set of 25 patterns for the structured design of MOOCs.	Design scenario workshop and Pattern Languages of Programs Conference (PLoP).
(ALARIO-HOYOS et al., 2014)	A conceptual framework in the form of a canvas, i.e., a visual representation of blocks or issues.	A case study consisting of six educators with technological background that participated in a workshop and used the proposed strategy to design a MOOC.
(BROUNS et al., 2014)	A networked learning framework for MOOC design.	The quality and validity of the pedagogical framework were not considered by the authors (future work).

Source: Elaborated by the author.

The specific approaches summarized in Table 9 are briefly described next.

Lee et al. (2016) developed a MOOC design model to support the practice of MOOCs development in Korea by specifying course development procedures and guiding strategies. They used (RICHEY, RITA C., 2014)'s conceptual model development procedure to build the MOOC design model. Firstly, a critical review of relevant literature was performed, and typical MOOC development processes were observed. Secondly, to validate the model an expert review with five educational technologists and MOOC researchers was conducted. The third step was an external validation research to test the effectiveness, efficiency, and usability of the model. According to Figure 10, the final version of the model has six procedural phases and nine steps, a slight variation of ADDIE model (Analysis, Development, Design, Implementation, Evaluation) (BRANCH, 2010; MOLENDA, 2003), but with specific explanations on what phase and which MOOC principles should be considered when designing such kind of course.

Figure 10 - (LEE et al., 2016)'s MOOC Design Model.



Source: (LEE et al., 2016).

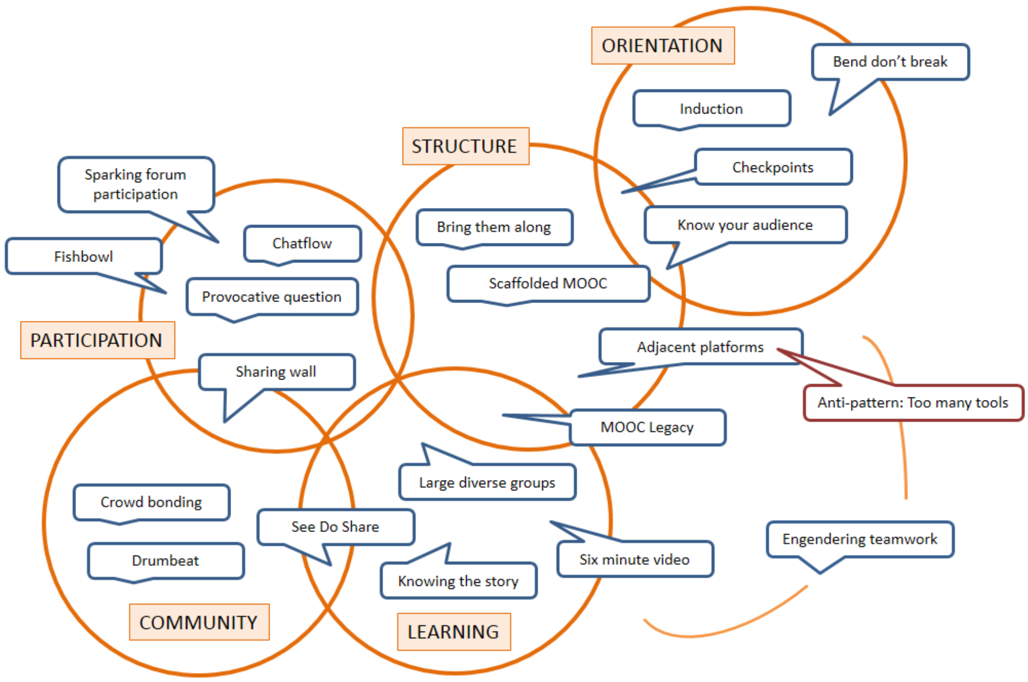
Another study was performed by Warburton and Mor (2015), which is named MOOC Design Patterns Project[27] and can in fact be understood as the main related work of this thesis. It was conducted in the University of Surrey (England) between 2014 and 2015. It focused on

---

[27] http://www.moocdesign.cde.london.ac.uk

practitioners who are making their first steps in online education, and also on experienced instructors who want to take a step back, reflect on and improve their practice. The project is focused on the challenges of active and collaborative MOOCs and, in particular, design-based teacher-training MOOCs. The authors used Participatory Pattern Workshop (PPW) methodology (MOR; WARBURTON; WINTERS, 2012) to review and to examine practitioners' experiences from designing, delivering, and facilitating MOOCs. They extracted transferable design knowledge from these experiences in the form of design narratives and captured design patterns from them. A Design Narrative is a semi-structured story that illuminates a particular attempt to address a real-world challenge, recounting an incident where the designer attempted to bring about a change in the user's world (MOR, 2013). As a result from running a series of PPWs, around twenty-one patterns[28] for the structured design of MOOCs were published (WARBURTON; MOR, 2015), as illustrated by Figure 11.

Figure 11 – MOOC Design Pattern Map.



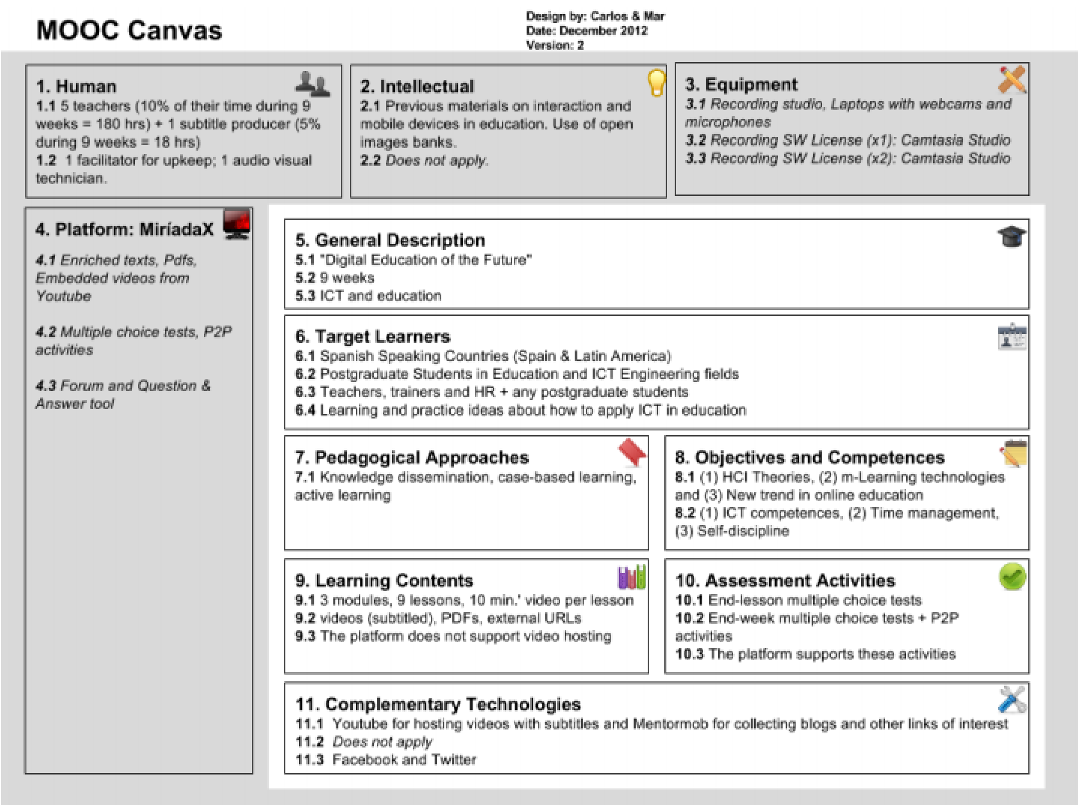
Source: (WARBURTON; MOR, 2015)[29].

In turn, MOOC Canvas is a visual framework that can be used by educators to describe and design MOOCs (ALARIO-HOYOS et al., 2014). The canvas is inspired by the ideas and the structure of the Business Model Canvas (OSTERWALDER; PIGNEUR, 2010), generally used to outline business model, but gathers the main issues of logistical, technological,

[28] Examples of Design patterns http://ilde.upf.edu/moocs/v/b1w and http://ilde.upf.edu/moocs/v/bvv
[29] http://www.moocdesign.cde.london.ac.uk/outputs/patterns

pedagogical, and financial nature that educators need to think during MOOC design. Such issues were distributed in 11 elements addressed through a set of questions that offers visual guidance for practitioners. Those elements were arranged in two categories: Available Resources (gray part in Figure 12) and Design Decisions (white part in Figure 12). Available Resources refer to the key resources that teaching staff have at their disposal at the moment of the MOOC design (e.g., human and intellectual resources; hardware and software resources) and the platform where the MOOC will be delivered. They are independent of the current design of the MOOC and do not affect each other, although they may affect design decisions. The MOOC Canvas shows a static picture of a specific moment in the design process. Different iterations can be built over the same MOOC design resulting into different versions of the MOOC Canvas. It is not intended to be a pattern for modelling and formalizing MOOCs, but a framework for the teaching staff to reflect and discuss about the main issues to be considered in the MOOC design, having them organized in a simple and visual way. Also, the MOOC Canvas can be used to provide a MOOC description at a glance, and to share the experience of designing the MOOC with other educators that may face similar design decisions in their courses.

Figure 12 - MOOC Canvas.



Source: https://www.it.uc3m.es/calario/MOOCCanvas/index.html.

Brouns et al. (2014) proposed a framework based on a set of pedagogical principles. The framework also approaches aspects related to access and registration, duration and structure, learning environment, learning process, teacher's and learner's role, facilitators team, activities, learning materials, communication, feedback and assessment, among others.

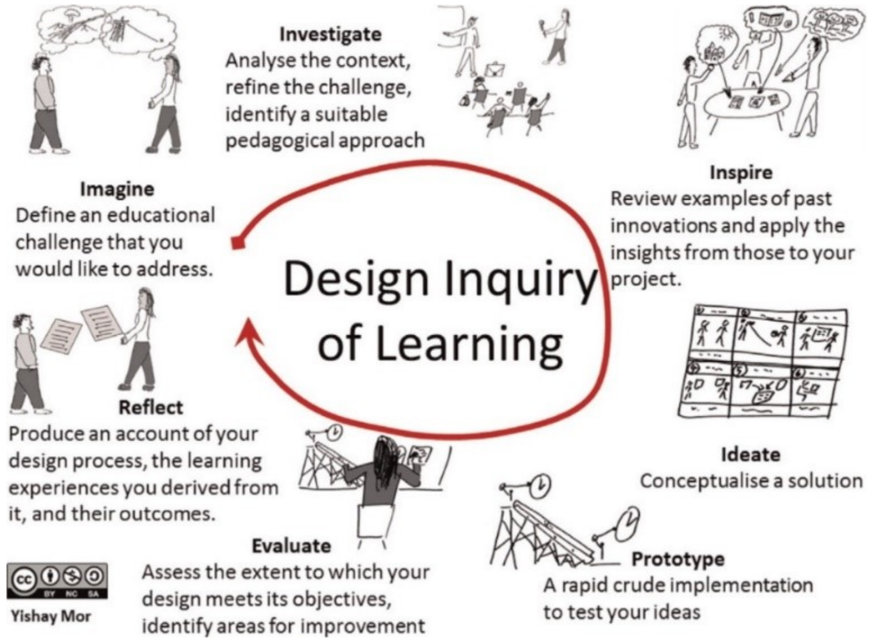
3.1.2 General approaches adapted for MOOCs

According to Sharif and Cho (2015), learning design models provide guidelines or frameworks that help to organize structures of procedures in designing and developing instructional activities. There are several learning design models (e.g., Dick and Carey, Kemp, ASSURE, and Rapid Prototyping), which are all somehow variations of the traditional ADDIE model (BRANCH, 2010; MOLENDA, 2003).

Some studies have applied or adapted traditional approaches to design MOOCs. For example, Croxton and Chow (2014) used the main **ADDIE** fundamentals as a framework for developing a MOOC case study to teach web design and usability principles and skills. According to them, ADDIE was chosen once it is a learner-centered rather than teaching-centered approach, thus it can be used in MOOC design in order to improve the creation of courses more effective and meaningful for learners. Based on experiences performing cMOOCs, Kukharenko (2013) presented general recommendations for each ADDIE step (analysis, design, development, implementation and evaluation) when designing a cMOOC.

Learning Design Studio (LDS), in turn, is a collaborative, blended, project-inspired framework based on the Design Inquiry of Learning (DIL) method for training teachers in the evidence-based use of educational technology (MOR; MOGILEVSKY, 2013). According to Figure 13, DIL combines an inquiry-based pedagogy with a design-based epistemology. The inquiry learning model states that learning is more effective when grounded in active exploration of questions, which are meaningful to the learners. Cross (2013) used LDS to design the OLDS MOOC, which is a MOOC about the Learning Design Studio. However, some limitations of this approach are described by (MOR; MOGILEVSKY, 2013), such as it is suitable for active practitioners and may be difficult to be implemented by inexperienced teachers; only MOOCs based on Design Inquiry of Learning can be built by instructors; and there is no framework or specific guidelines to support instructors when designing for learning in MOOCs or in another course format.

Figure 13 - The design inquiry of learning cycle.



Source: (MOR; MOGILEVSKY, 2013).

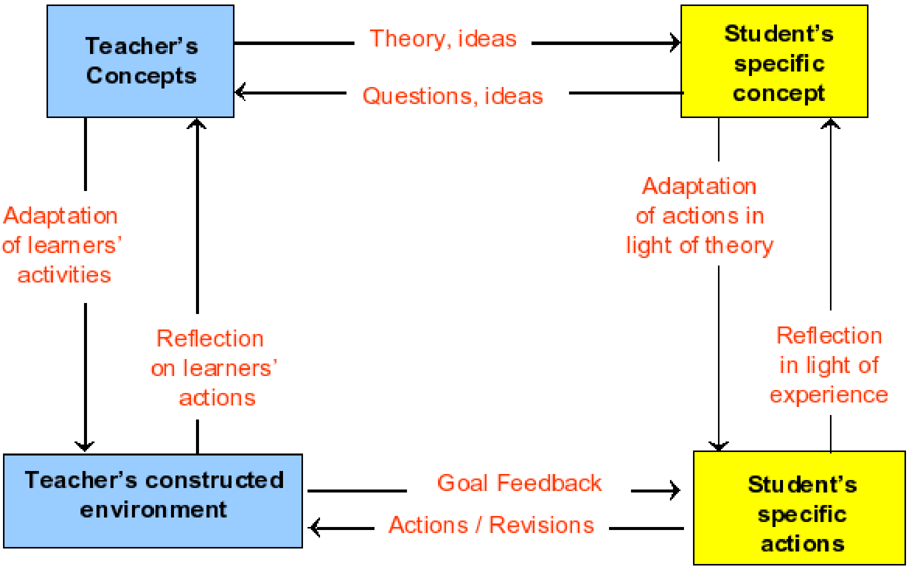
The **Carpe Diem** is a team-based approach to design for learning that has been researched and developed since 2001 and applied to several purposes[30,31](SALMON; WRIGHT, 2014). Salmon et al. (2015) used this process to design the Carpe Diem MOOC, which is also a MOOC about the Carpe Diem learning design process. This intervention is a practical learn-by-doing method, a two-day workshop model designed to help small teams to work together for active and interactive learning and to get their unit/module/course into fully digital, blended or mobile mode. The model is broken up into six sequential, progressive and collaborative tasks, led by a trained facilitator familiar with the process. 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) planning the next steps.

The **Conversational Framework** model proposed by Laurillard (2002) is a strategy that have been adapted and used to design MOOCs and also MOOC platforms, as reported in (KING et al., 2014) and (DICKENS; WHITE, 2015). According to Clow (2012), learning takes place through a series of ‘conversations’ between a teacher and a student (and with other students), underpinned by reflection and adaptation. According to Figure 14, these conversations happen

[30]Carpe Diem Learning design: Preparation and Workshop available at http://www.gillysalmon.com/uploads/1/6/0/5/16055858/carpe_diem_planning_process_workbook_v17-january_2015.pdf
[31] http://www.gillysalmon.com/carpe-diem.html

on two levels: (i) at the level of conception or description, and (ii) at the level of action, in order to link theory to practice.

Figure 14 - Laurillard's Conversational Framework.



Source: http://edutechwiki.unige.ch/en/Laurillard_conversational_framework.

3.1.3 Learning design principles for MOOCs

Some authors have also proposed design principles and essential characteristics that should be considered when designing a MOOC. Such findings were retrieved from literature review or by their own practice (e.g. lessons learned from experiments, case studies, field evaluation).

Smith et al. (2017), for example, compare two ways of developing and delivering MOOCs: one using a large-scale platform (e.g. FutureLearn), and other developing self-made MOOCs by an in-house small team. From this comparison, some assumptions were observed. For example: (i) the *audience* can vary in size and expertise, and this difference affects how MOOCs are designed; MOOCs for users with particular skills or applied in a specific context tend to have smaller audience but with more commitment to the course; MOOCs for general audience need a careful design to reduce barriers to participation for their participants; (ii) the chosen *pedagogy* has a significant impact on course design; moreover, there is a range of pedagogic strategies between cMOOCs and xMOOCs that still need to be explored; (iii) the chosen *MOOC platform* also impacts course design, not being just a technical decision; large MOOC platforms (e.g., Coursera, Udacity, and FutureLearn) provide to educators a robust process to create and deliver courses; also, they have a huge base of users and good publicity mechanisms to gather large audiences of leaners. On the other hand, they have low pedagogic flexibility support; they often are based on single, prescribed pedagogic approach, generally a didactic approach with readings, video clips, and automatically marked formative assessment tasks.

Hatzipanagos (2015) explored key learning design characteristics of MOOCs and essential elements for independent learning and student support. A map of learning design features of MOOCs is presented in Table 10.

Table 10 - A map of learning design features of MOOCs.

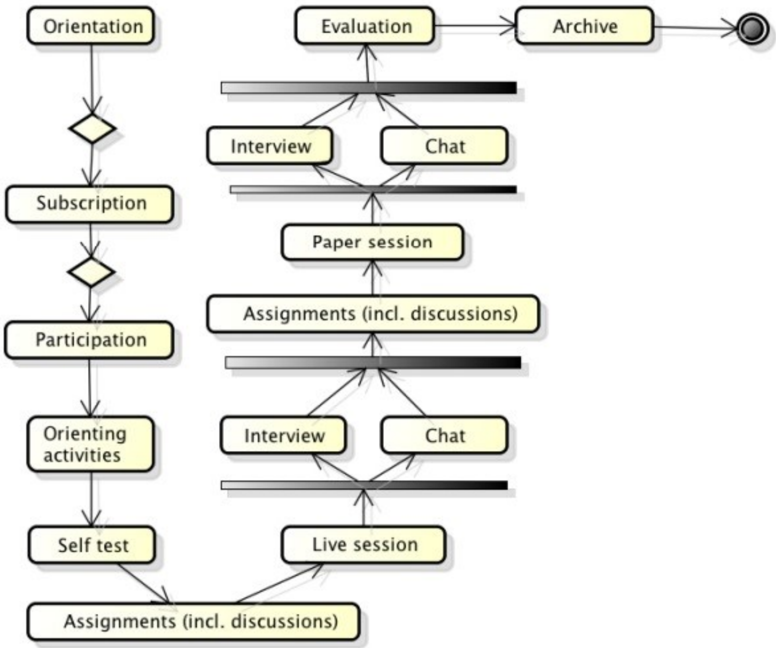
<table>
<tr><td colspan="12">MOOC learning design features</td></tr>
<tr><td colspan="12">Interactive video-based lectures (predominantly) or other content</td></tr>
<tr><td colspan="12">Computer mediated communication media</td></tr>
<tr><td colspan="3">Wikis</td><td colspan="3">Forum</td><td colspan="3">Blogs and microblogging</td><td colspan="3">Social networks</td></tr>
<tr><td colspan="12">Badges: Tutor or peer awarded</td></tr>
<tr><td colspan="12">Learning analytics</td></tr>
<tr><td colspan="6">Adaptive Learning tools</td><td colspan="6">Content trackers</td></tr>
<tr><td colspan="12">Assessment</td></tr>
<tr><td colspan="4">Automated</td><td colspan="4">Peer assessment</td><td colspan="4">Self-assessment</td></tr>
</table>

Source: (HATZIPANAGOS, 2015).

Romero and Usart (2013) tried to introduce the design of a MOOC for entrepreneurship education that aims to go one step further by integrating the use of serious games as a key part of the methodology for teaching and learning entrepreneurship basics in the context of a MOOC.

In addition, Rubens (2014) presents the learning design that has been developed for online master classes for professional development at the Open University of the Netherlands. His strategy tries to find a balance between *flexibility* and *pedagogical principles* of distance education for adult learners. For instance, live sessions instead of pre-recorded videos may enhance learner-instructor interaction. The first day is focused on orientation and *activation of prior knowledge*. An orientation test and self-test are used for these purposes. In addition, the instructional design process to develop the course is based on an iterative process that was oriented at principles of agile software development. The setup of the learning design of the online master classes is summarized in Figure 15.

Figure 15 - Activity diagram of the learning design of online master classes.



Source: (RUBENS, 2014, p. 4).

3.1.4 Guidelines from MOOC Providers and Educational Institutions

We identified that MOOC teams are also using guidelines developed by MOOC providers (e.g. Coursera, MiríadaX) and even resources or best practices made available by their own universities. Some examples include: (i) a report[32] summarizing the experience of the University of Edinburgh in offering its first six massive open online courses in partnership with Coursera; (ii) a report[33] on a MOOC addressed to primary school teachers in collaboration with UNESCO/IITE, through Coursera platform, coordinated by Prof. Laurillard from the Institute of Education, University College London; (iii) a short report[34] summarizing four years of the University of Toronto exploration of the potential of MOOCs under the umbrella of the broader Open UToronto project; (iv) a report[35] that analyzes the UK MOOC market from 2012 to 2015,

[32] https://www.era.lib.ed.ac.uk/handle/1842/6683
[33] https://iite.unesco.org/files/news/639194/Anatomy_of_a_MOOC.pdf).
[34] http://www.ocw.utoronto.ca/wp-content/uploads/2015/10/MOOC-Report-on-Third-Year-of-Activity_OCT_2015.pdf
[35] https://www.mooclab.club/Reports/UK%20MOOC%20Report%202016.pdf

drawing meaningful information from data collected from the provider institutions; and (v) a practical review[36] of the first two MOOCs of the University of Glasgow.

Guidelines from MOOC providers and educational institutions helped us to understand the current status regarding MOOCs design as well as to identify the related vocabulary and the stakeholders involved in the MOOC development process. We also used such partial results to formulate questions for a survey of MOOC practitioners, which is detailed next.

3.2 AN EXPLORATORY SURVEY ON DESIGN STRATEGIES FOR MOOCS

In addition to reviewing the learning design strategies currently in use by MOOC teams, we also carried out a survey where MOOC instructors were asked about their experiences designing MOOCs.

This exploratory study was developed using the main ideas described in (KITCHENHAM; PFLEEGER, 2002, 2001) and (WOHLIN et al., 2012, p. 12). According to them, the survey research method can be used to collect information to describe, compare or explain knowledge, attitudes, and behavior. In general, a survey consists of a set of well-defined activities, such as settings objectives, scheduling the survey, designing the survey, preparing the data collection instrument, validating the instrument (survey pilot), selecting the participants, scoring the instrument, analyzing the data and reporting the results, among others.

3.2.1 Survey design

The survey was guided by the Research Questions (RQ) presented in Table 11.

Table 11 - Research questions that guided the survey study.

RQ1. What are the instructors' profiles that offer MOOCs?
RQ2. How MOOCs have been developed?
RQ2.1. What are the MOOC platforms or providers used to deliver the course?
RQ2.2. What are the areas of study?
RQ2.3. How long are the MOOCs (in weeks)?
RQ2.4. What are the preferred learning design strategies when designing MOOCs?
RQ2.5. What are the preferred pedagogical approaches when designing MOOC?
RQ2.6. What are the main learning design digital tools used to support the design for learning in MOOCs?

[36] https://www.gla.ac.uk/media/media_395337_en.pdf

RQ2.7. Are the most part of the learning objects or learning resources used in the MOOCs adapted from other contexts or developed specifically for MOOCs?
RQ3. How the MOOC teams are formed?
RQ4. What are the methods used to evaluate MOOCs quality?
RQ5. What are the limitations or challenges faced when designing MOOCs?

Source: Elaborated by the author.

In order to construct the survey instrument (i.e., an electronic unsupervised questionnaire), firstly we looked through the literature. Other studies on this topic were investigated and their data collection mechanisms were analyzed (HONE; EL SAID, 2016) in order to avoid duplicate research and to improve our research upon previous studies. Secondly, we used our own literature review (chapters 2 and 3) to elaborate the questions and their possible answers.

The instrument was developed using Google Forms. To achieve greater representation, we created two versions: one in English available at https://goo.gl/HHdc1C, and another one in Portuguese, which is available at http://goo.gl/forms/jNDxBGGG5cOWRCqL2. Both versions had the same structure. The first part dealt with personal data including gender, age, professional situation, and country. In addition, we asked the participants about their knowledge and understanding of teaching in virtual learning environments and their main motivation factor for diving into MOOCs. The second section was concerned with the MOOC developed by the respondent: the provider used to deliver the course, the MOOC area, number of weeks delivering the content, pedagogical approach, the learning design strategy used to develop the activities map, among others. Issues related to the development of the MOOC in team were addressed in the third part of the questionnaire. Finally, general issues, questions, and comments were also approached.

A pilot survey was conducted before the main survey in order to improve the quality of the questionnaire. Misleading questions and poor instructions were identified and adjusted. The pilot was evaluated by a group of eight members of target population and two specialists related to the research.

3.2.2 Sample population

A random sampling method (LAZAR; FENG; HOCHHEISER, 2010, chap. 5) was used to select the subjects; they were invited considering the following inclusion criteria: people who developed at least one MOOC in some moment of their professional life, in team or individually, and delivered the course using well-known MOOC providers (e.g. Coursera, MiríadaX, FutureLearn, among others).

In general, MOOC providers make available a list of partner institutions, the courses delivered by them into the provider, and their instructors. Each instructor has a page into the provider and this page can be used to describe the instructor's profile and ways of contacting, among other relevant issues. Thus, the potential subjects and their e-mails were identified from a search in the following MOOC providers: Coursera (USA-based), MiríadaX (Europe and Latin America-based), FutureLearn (UK-based), and Tim Tec (Brazil-based). We also collected e-mail addresses available in the papers investigated during the systematic study (Chapter 2). Some e-mail addresses were also identified from the MOOC aggregator named MOOC List[37]. In the Brazilian case, specifically, two different e-mail distribution lists were used to contact the target user population and to send the questionnaire: (i) SBC-ListaIE (List of the Special Committee on Information Technology in Education); and (ii) SBC-Lista (General list of the Brazilian Computer Society).

3.2.3 Data Analysis

Data collection was performed in two steps: December 2015 to July 2016 (English version); July 2016 to November 2016 (Portuguese version). At the end, 91 questionnaire responses were collected; participation was voluntary and no incentives or rewards were offered.

The questionnaire was submitted to 304 e-mails and two discussion lists (in Portuguese). Thus, it is difficult to define the response rate. If the e-mail lists are despised, the response rate is approximately 30%. The main findings are described following.

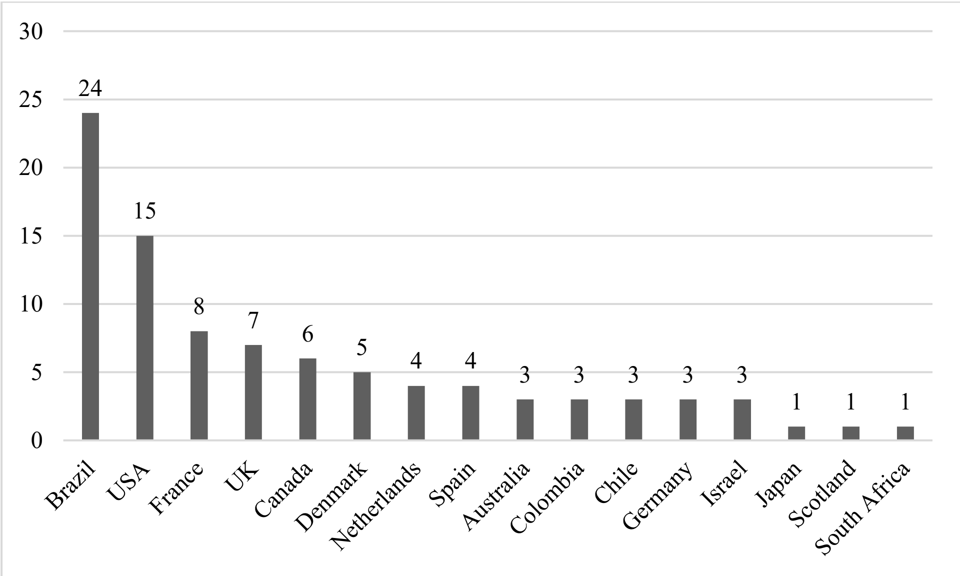
RQ1. What are the instructors' profiles that offer MOOCs?

The sample included 69 male participants (75.8%) and 22 female participants (24.2%). The majority (31; 34%) were aged 51 or more; 30 participants (33%) were aged between 41 and 50; 21 participants (23.1%%) were aged between 31 and 40; and 9 participants (9.9%) were aged 30 or under. Analyzing the national and international levels, in Brazil the majority (52.2%) were aged between 31 and 40, while in the international context the majority (41.2%) were aged 51 or more.

[37] https://www.mooc-list.com

Figure 16 summarizes the diversity of the survey participants, highlighted by their geographic region, having people from 16 different countries. The majority was from Brazil, the USA, and France.

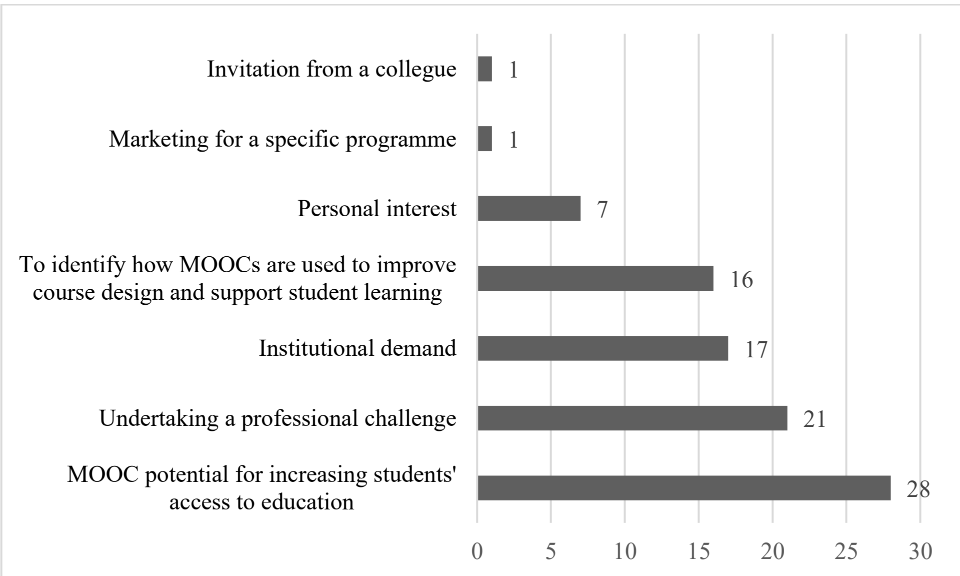
Figure 16 - Distribution of respondents by Country.



Source: Elaborated by the author.

The subjects were also asked about their main motivation to develop MOOCs. According to Figure 17, the majority (30.76%) decided to design and deliver MOOCs because of the MOOC potential for increasing students' access to education.

Figure 17 - What was your main motivating factor for diving into MOOCs?



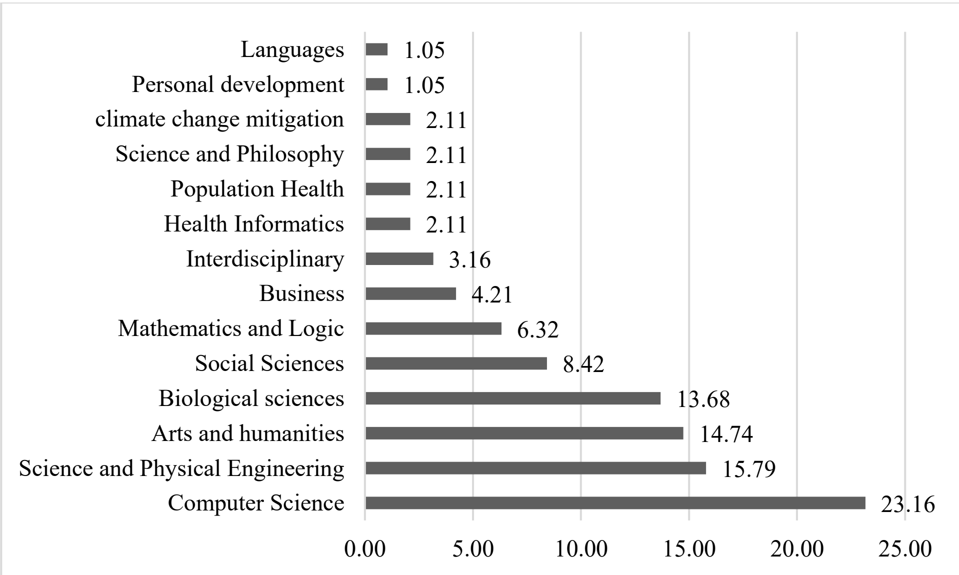
Source: Elaborated by the author.

RQ2. How MOOCs have been developed?

Regarding the MOOC platforms or providers, which the respondents used to deliver MOOCs, majority answered Coursera (74.7%), followed by Moodle (13.2%), Institutional platforms (4.4%), MiríadaX (2.2%), Tim Tec (2.2%), Veduca (2.2%), and Openredu (1.1%). The options Tim Tec, Veduca, and Openredu were only answered by the Brazilian respondents.

Figure 18, in turn, represents the distribution of MOOCs by their respective themes or knowledge areas, in percentage. In general, there is a huge concentration of MOOCs about Computer Science, followed by Science and Physical Engineering. Analyzing the national and international levels, in Brazil there is a concentration of MOOCs about Computer Science and Arts and Humanities while in the international context the focus is on Computer Science, Science and Physical Engineering, and Biological Sciences.

Figure 18 - Teaching areas (in %).

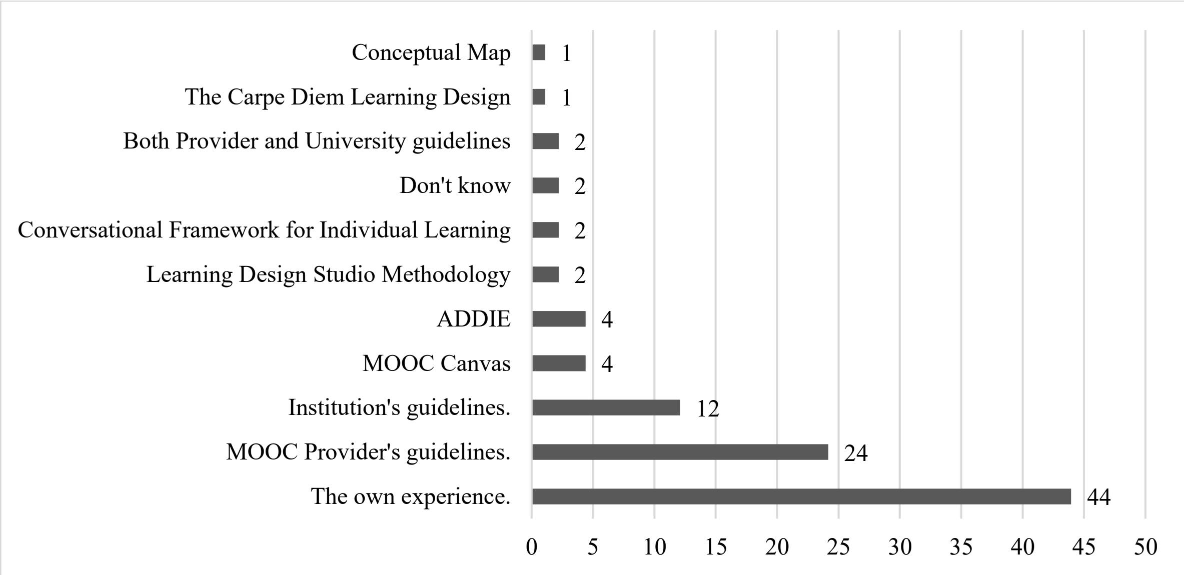


Source: Elaborated by the author.

In general, the MOOCs considered in this study lasted 6 weeks (38.2%), 8 weeks or more (27.9%), and 4 weeks (13.2%) in the international level; and 8 weeks or more (34.8%), 4 weeks (34.8%), and 6 weeks (8.7%) in the national level.

Regarding the preferred learning design strategies to design MOOCs, Figure 19 highlights that the majority (44%) develop MOOCs using their own experience (i.e., no defined approach is used to guide the MOOC development process). Such gap was also identified through the systematic mapping presented in Chapter 2. Other strategies used are based on guidelines produced by MOOC providers (24%) or institutions/universities (12%).

Figure 19 - Strategies used to design for learning in MOOCs (in %).



Source: Elaborated by the author.

Another gap identified through the systematic mapping presented in Chapter 2 and now confirmed using the survey study is regarding the preferred pedagogical approaches used to design for learning in MOOCs. The majority of the respondents have adopted content-based approaches (e.g., based on video-lectures, forums, formative quizzes, and automatic assessments), as summarized in Table 12.

Table 12 – Preferred pedagogical approaches.

Approaches	Percent
Content-based (video-lectures, forum, quiz, automatic assessments).	58
Problem-based learning.	14
Project-based pedagogy.	11
Inquiry learning.	5
I’m not able to define the main pedagogical approach used.	4
No Lectures. Only active learning activities.	3
Lectures, formative quizzes, active learning activities, evaluation.	1
Interviews and reflective activities.	1
Videos and Forum.	1

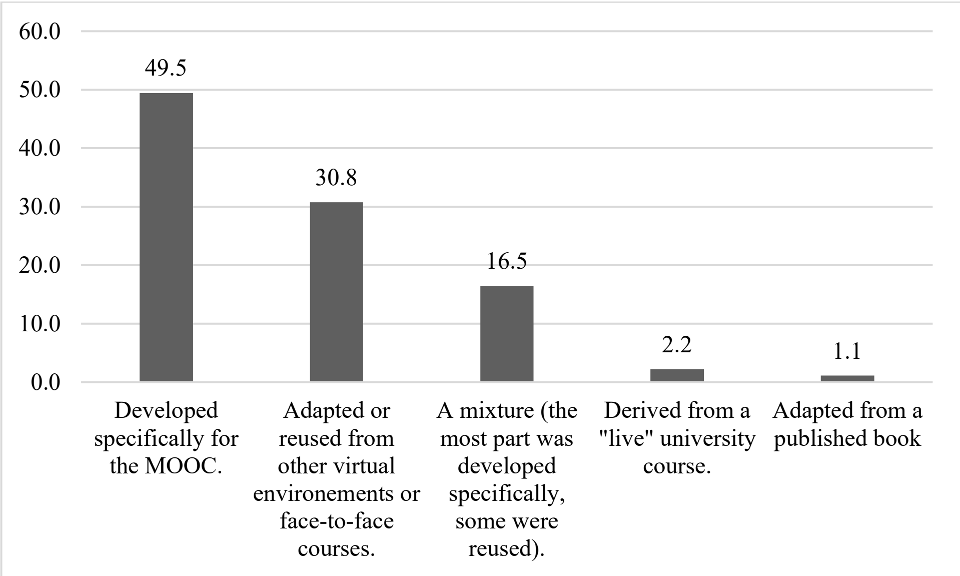
Source: Elaborated by the author.

The respondents were also asked about the use of digital tools to support the MOOC development process. 79.1% did not use any kind of tool, 10% used Google Docs, 2% used

Integrated Learning Design Environment[38] (HERNÁNDEZ-LEO et al., 2013). Other answers included other tools, such as CompendiumLD[39], institutional tools, Pedagogical Patterns Collector[40], ScenEdit[41], Cloudworks[42], CMapTools[43], and Quizlet[44].

We were also interested in understanding the origin of resources (e.g., videos, texts, figures) the respondents used to deliver their MOOCs. According to Figure 20, the majority (49.6%) of the resources were developed specifically for the related MOOC.

Figure 20 - Origin of the learning resources used by the survey's respondents in their MOOCs.



Source: Elaborated by the author.

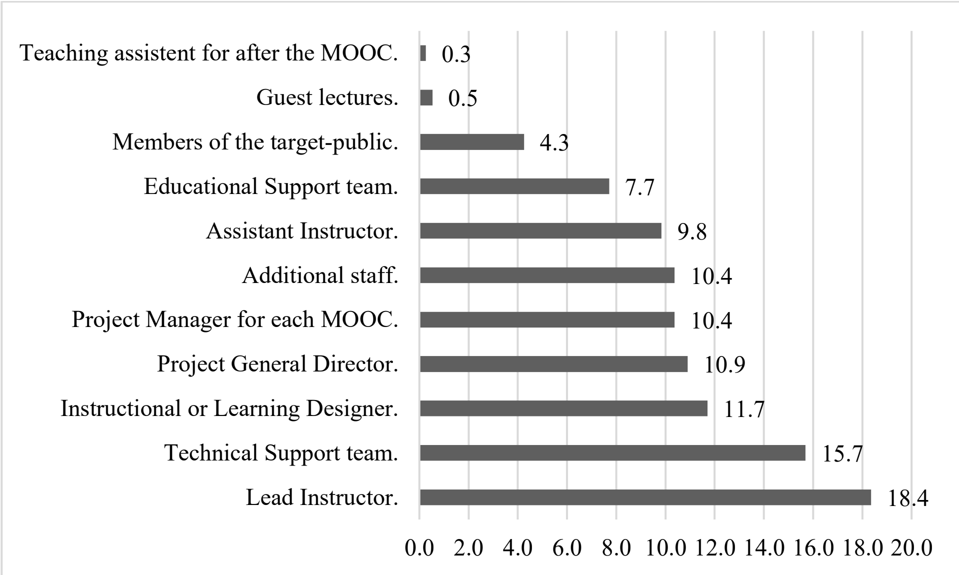
RQ3. How the MOOC teams are formed?

The participants were asked about the existing roles that made part of their MOOCs development process, regardless of whether a person has taken one or more roles. According to Figure 21, few MOOCs encompassed the rules of teaching assistant to support students after the MOOC delivery (0.3%), participation of guest lectures (0.5%), and members of the target-public (4.3%). The role of Educational Support team is also minority (7.7%); it means scientific staff or someone who help MOOC instructors to find legal, safe, and free resources for the programs, among other things. Additional staff was in some way required (10.4%); it means special multimedia developer, professional video editor, cameraman or someone responsible

[38] https://ilde.upf.edu/about
[39] http://compendiumld.open.ac.uk
[40] http://www.ld-grid.org/resources/tools/pedagogical-pattern-collector
[41] http://www.ld-grid.org/resources/tools/scenedit
[42] http://cloudworks.ac.uk/about/about
[43] https://cmap.ihmc.us/cmaptools/
[44] https://quizlet.com

for several topics such as media publication and support in the development of educational material. The rule of Project Manager was also very considered (10.4%), it means someone generally from the own MOOC institution/university and who makes the bridge between the MOOC provider (e.g., Coursera, MiríadaX) and the MOOC Team.

Figure 21 - Frequent roles in MOOC teams.



Source: Elaborated by the author.

Furthermore, in general, the MOOC teams were not geographically distributed (71.4%). The rest of the distribution involved people situated in different cities (7.7%); different states (5.5%); different universities in the same city (1.1%); and different countries (13%). The last answer, i.e., different countries, was only identified in the international context.

RQ4. What are the methods used to evaluate MOOCs quality?

Regarding the strategies used to verify MOOC quality, the majority of respondents (38.6%) adopts post-course surveys, followed by internal quality assurance procedures generally available by MOOC providers (20.9%). Coursera and MiríadaX, for example, provides specific guides containing tasks that must be performed by the MOOC team (e.g., manual review of the course structure, course content, grading and certificates), while other items are reviewed by the Provider's Staff (e.g., course settings, video subtitles, weekly messages, certificate assets, among others). Table 13 summarizes the main strategies identified through the survey study.

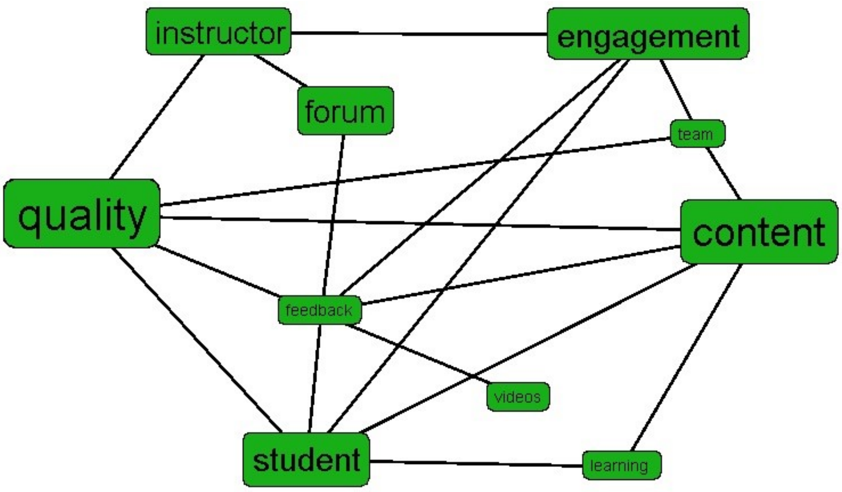
Table 13 – Preferred strategies to check MOOC quality.

Approaches	Frequency	Percent
Post-course survey.	59	38.6
Internal quality assurance procedures of the provider (e.g. Coursera, edX).	32	20.9
Forum.	29	19.0
The course's quality was not formally evaluated.	15	9.8
Heuristic evaluation.	8	5.2
Formal quality control procedure established by the institution/university.	5	3.3
Own surveys (formative and somative) and specific meetings.	2	1.3
Reflective journals.	1	0.7
Beta testers.	1	0.7
Students ratings.	1	0.7

Source: Elaborated by the author.

We also used an open-ended question to identify the participants' opinion about main factors related to MOOC quality. To review the answers, we used an Educational Text Mining tool named Sobek Graph[45]. Sobek looks for frequent terms and their relationship in a text. In Figure 22, larger nodes represent more frequent terms and connections represent relationships between them. As we can see, MOOC quality is dependent of factors related to the instructor and the involvement of the MOOC team, content quality, the student active role as well as the use of strategies to support learners' engagement (e.g. videos, feedback, among others).

Figure 22 - Graph extracted from the survey participants' answers about MOOC quality.



Source: Elaborated by the author (generated by Sobek Tool).

[45] http://sobek.ufrgs.br/

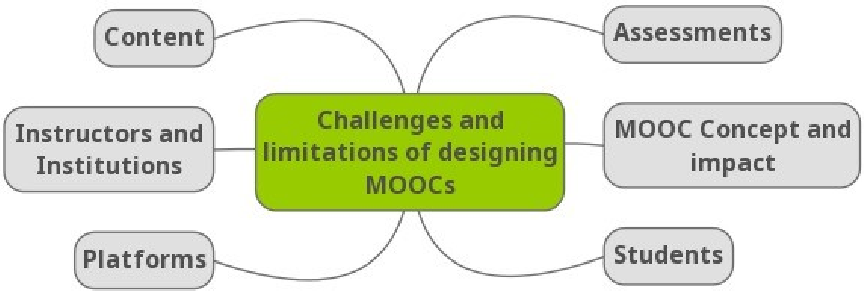
A closer analysis of the participants' answers showed that aspects related to MOOC quality can be grouped into the following topics.

- **MOOC quality is achieved when** "the course effectively enables student learning", it means that "the student can achieve the content and objectives stated in the program", and "the students learn something valuable and they can apply this knowledge".
- **To achieve such level of quality, some elements must be considered**: "use of strategies to keeping students engaged"; "good assignments and videos"; "flexibility in interactive problems"; "formative activities, social interaction, collaborating tools and activities, engaging video-lectures, clear instructions"; "quiz responses so you know the ideas are reaching the audience"; "high quality content and multiple modes for learner feedback and engagement.", "guided, interaction, adapted to different levels", "good pedagogy"; "beta tests"; "content knowledge and innovative learning design".
- **Challenges to achieve MOOC quality include**: "students' interest"; "the platforms, and the challenge of teaching without a present teacher"; "the quality and communication ability of the instructor"; "the quality of the scientific and technical teams"; "engagement of the provider team"; "level of instructor interaction during the course, especially on discussion forum"; "the ways in which the content is presented"; "passion of the teacher"; "instructor creativity; pedagogical advice on clarity of lectures; technical level of materials"; "commitment of students to participate in the forum and complete assignments"; "software reliability"; "teacher background, support staff".

RQ5. What are the limitations or challenges faced when designing MOOCs?

To conclude the survey, we also asked the participants about the challenges they faced when designing for learning in this context. Figure 23 summarizes the main findings. Such findings and some participants' testimonials are briefly presented next.

Figure 23 - Main challenges when designing MOOCs, according to the survey participants.



Source: Elaborated by the author.

- **Content**. Challenges and important issues related to the development and reuse of learning materials. It includes: "lack of focus on audience during the content development process"; "difficult to find and produce open access materials"; and "updating the content is very costly".
- **Instructors and Institutions**. Personal and institutional issues involving instructors and their teams. It includes: "instructors are not given enough time/resources by universities to facilitate proper development"; "lack of recognition from institution"; "time consuming"; "general lack of commitment/understanding about educational policy about MOOCS at the institutional level (for educational profile, or possible monetization)"; "missing support".
- **Platforms**. Technical issues regarding MOOC environments that may hamper effective learning by the students. It includes: "lack of flexibility in the platform"; "platforms can be limiting and assume a rather simple style of learning, and single level of participation".
- **Assessments**. Difficulty to think and use different ways of assessment activities to enhance learning. It includes: "lack of focus on audience in order to design meaningful evaluation, feedback activities, and interactive learning assignments".
- **MOOC concept and impact**. Lack of knowledge about the MOOC concept and also doubts about their impact on learning. It includes: "lack of support in how we design an innovative MOOC"; "Not yet sure of the impact of MOOCs on students".

- **Students**. Personal questions related to students. It includes: "the broad audience with limited time and experience leads to dropouts"; "low interactivity"; "the major challenge is to stimulate participants to complete the course".

3.2.4 Concluding remarks

The exploratory survey helped us to confirm the strategies the instructors have used to design MOOCs and the main challenges they have faced. Furthermore, the survey helped us to define a big picture on the development of MOOCs across the world.

We can infer that issues related to the lack of well-defined and validated strategies to support practitioners in the MOOC development are still challenges to be overcome worldwide. Thus, our proposal to minimize this gap is LDF4MOOCS, a learning design framework for MOOCs that is grounded on Software Engineering principles and pedagogically informed by Flipped Learning ideas, as described in Chapter 5.

Next, we present a set of desirable characteristics or learning design requirements for MOOCs projects based on the studies presented throughout this chapter and also from the systematic study conducted (Chapter 2).

3.3 A Resume of Learning Design Requirements for MOOC Projects

The term "learning design requirements" was used by (CONOLE et al., 2008) to define the resulting product of the requirements elicitation phase in a methodology for learning design. Shani and Docherty (2003, p. 25) also defined learning design requirements as the set of necessary but not sufficient learning requirements for achieving learning, which might include: a legitimate forum for exchange of ideas, a set of process that facilitate ongoing dialogue; development, use or adoption of tools that facilitate learning, among others.

A study on essential learning design requirements for MOOC projects was also conducted. As we described on sections 3.1 and 3.2, different authors have proposed essential characteristics that should be considered by MOOC teams when developing a MOOC project. Although they can differ from author to author, such discussion can guide the level of coverage and depth needed when planning a MOOC. A summary of these common requirements is presented in Table 14. To develop this table, in particular, five main studies on learning design requirements for MOOCs were considered. They are also listed following.

Table 14 - A set of learning design requirements for MOOCs

Requirements	W1	W2	W3	W4	W5
Student-centered learning	x	x	x	x	
Role of the teacher	x		x	x	x
Active learner	x		x	x	x
Divergent learning	x	x	x		
Structure	x	x			x
Concrete content presentation	x	x	x	x	
Feedback	x	x	x		
Collaborative and social learning	x	x	x		x
Accommodating differences.	x	x		x	
Assessment and understanding	x		x	x	x
Self-regulated learning			x	x	x
Deep-learning			x	x	

Source: Elaborated by the author.

Legend:

Work 1: AMP: A tool for characterizing the pedagogical approaches of MOOCs (SWAN et al., 2014).

Work 2: Designing for Open Learning: Design Principles and Scalability Affordances in Practice (FIRSSOVA; BROUNS; KALZ, 2016).

Work 3: Elements of Learning Design for MOOCs (GULATEE; NILSOOK, 2014).

Work 4: MOOC Design Principles. A Pedagogical Approach from the Learner's Perspective (GUÀRDIA; MAINA; SANGRÀ, 2013).

Work 5: Creating MOOC Guidelines based on best practices (SPYROPOULOU; PIERRAKEAS; KAMEAS, 2014).

- **Student-centered learning**. In a macro level, consider learning and the integration of learners' goals, experiences, and abilities into their learning experiences instead of focusing on instruction, instructional materials, and absolute goals. This requirement guides pedagogical approaches, the development of educational content, and teaching activities, among other important issues.
- **Role of the teacher.** Teachers should act as learning designers, investigating different strategies to integrate learner-centered approaches for promoting student empowerment and engagement.
- **Active learner.** Learners should feel engaged in the process of creating, sharing, formalizing, and evaluating knowledge themselves.

- **Divergent learning**. In a real scenario, there are many ways to solve a given problem. Thus, activities that allow more than one path or multiple correct answers are more desirable for the MOOC context.
- **Structure**. The course has a well-defined and organizational structure, easy to understand and navigate. Furthermore, there are clear guidelines about what the students should do.
- **Concrete content presentation.** The content used in the course (e.g., videos, demonstrations) include real word and contextualized concepts, examples, and solutions.
- **Feedback.** Consider feedback strategies that are clear, automatic, personalized, and constructive.
- **Collaborative and social learning.** Use of teamwork activities, discussion forums, integration with social applications, exchange spaces where students can create and share learning sources, dialogue, and support their peers. Opportunities to support the creation of groups (virtual or even face-to-face), so they can also exchange interests. Related guidelines, rules, and netiquettes must be provided.
- **Accommodating differences.** Involves different adaptations including digital materials, activities, types of videos, languages, accessibility, cultural aspects, learning goals, use of diverse resources (e.g., considering a MOOC about programming, the student should be able to choose if he/she wants to produce an answer in Java, C, or Python).
- **Assessment and understanding.** Elaborate authentic strategies that enhance self and peer assessment, suggest creation and sharing of personal e-portfolios and related materials, and motivate effective application of the knowledge acquired.
- **Self-regulated learning**. Provide strategies and suggestions that support learners in defining a learning plan, personal goals, and agenda. Also specify clear information about schedules, assignments, pedagogical strategy adopted, among others.
- **Deep-learning.** Stimulate learners to apply in real contexts the main skills developed and content learned during the course. Motivate them for engagement and community learning opportunities.

It is important to highlight that the learning design requirements previously identified helped us to define the main phases, activities and fundamentals that were considered to propose the LDF4MOOCs framework, which is the main contribution of this work and will be described in Chapter 5.

3.4 SUMMARY

This chapter provided a general but concise landscape on the design and development of MOOCs in the global scenario, with a focus on strategies to design for learning in this context. Our intention was not to determine which strategy is better but rather to explore them and to find gaps as well as links or common MOOCs characteristics under the view of learning designers and educational technologists.

The main strategies identified during the systematic review process (Chapter 2) were described and analyzed. In addition to the review, we also performed a survey with instructors who have developed and delivered MOOCs, in order to confirm the strategies they have used to design MOOCs and the main issues they have faced.

In short, we noticed few approaches aimed to specifically improve the learning design of MOOCs. Furthermore, they do not provide a comprehensive information about how MOOCs should be developed; they neither explicitly describe their development and evaluation process nor their benefits or impacts on MOOCs design. Traditional approaches also have been applied for the MOOCs context; for example, some strategies used ideas based on the ADDIE model, but few specific MOOC characteristics were considered during the design. Based on lessons learned from experiments, case studies and field evaluation, some authors have also proposed design principles and essential characteristics that should be considered when designing a MOOC; however, they only provide general guidance for MOOCs design.

We conclude this chapter with a set of desirable characteristics or learning design requirements for MOOCs projects based on the studies presented throughout the chapter and also from the systematic study (Chapter 2). However, as Koper and Tattersall (2005, p. 14) argued, design principles and characteristics like those do not provide MOOC teams with enough guidelines actually to design courses, i.e., they can be used to check whether an existing design meets the requirements, but they are not practical enough for a course developer.

Considering this context, a Learning Design Framework for MOOCs, named LDF4MOOCs, is proposed and evaluated in this Ph.D. research. The framework consists of: (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 supporting resources (artifacts and digital tools).

In the next chapter, we provide an overview of the subjects that underlie the Educational Design Pattern Language, which is the main element of the LDF4MOOCs framework. We present the main concepts of patterns and pattern languages, including a historical perspective, relevant definitions of the area and a discussion on educational design patterns and related examples.

4 PATTERNS AND PATTERN LANGUAGE

There are different mechanisms to capture and encapsulate knowledge related to learning design (KOPER; TATTERSALL, 2005). For instance, theories consisting in a set of design principles; identification of best practices in teaching and learning; and the formalization of knowledge and best practices through patterns and pattern languages.

According to Pressman and Maxim (2014), patterns constitute a mechanism for capturing domain experience and knowledge to allow it to be reapplied when a new problem is encountered. In general terms, a pattern describes a solution to a problem in a recurring manner. A pattern language, in turn, is a way of subdividing a general problem and its complex solution into a number of related problems and their respective solutions.

This chapter covers the background on patterns, providing the theoretical basis to understand an Educational Design Pattern Language for MOOCs, which is proposed as the main element of the Learning Design Framework for MOOCs (LDF4MOOCs). In Section 4.1 we briefly introduce the roots of the pattern-based design approach proposed by Christopher Alexander. In sections 4.2 and 4.3 we highlight key studies and concepts that helped to spread the patterns philosophy and usage. The landscape of patterns application in the educational domain is presented in Section 4.4. Current studies that investigate the relation between patterns and MOOCs are presented in Section 4.5. The summary of this chapter is given in Section 4.6.

4.1 BACKGROUND

The idea of patterns, as we know and use nowadays, was firstly defined by a building architect, Christopher Alexander, who recognized that a recurring set of problems is encountered whenever a building is designed (PRESSMAN, 2009). Such recurring problems and their solutions are characterized as patterns. According to Alexander, Ishikawa and Silverstein (1977), each pattern describes a problem that occurs over and over again in our environment and then describes the core of the solution to that problem in such a way that anyone can use the solution a million times over without ever doing it the same way twice.

Patterns have received much attention in several areas due to their potential to act as a simple way to describe and share tacit knowledge and support new product design. Despite their origins in the field of architecture, notable applications are mainly in software development. In fact, according to Pressman (2009), Alexander's ideas were first translated into the software world mainly by (BUSCHMANN et al., 1996; GAMMA et al., 1993).

Having software context as an example, patterns have been divided or organized into types according to their levels of abstraction. As stated by Pressman (2009), “at each step, the problems you consider and the solutions you propose begin at a high level of abstraction and slowly become more detailed and specific”. Buschmann et al. (1996), for instance, defined three types of software pattern categories as follows (i) architectural patterns, which expresses a structural organization schema for software systems; (ii) design patterns, which provides a scheme for refining the components of a software system, or the relationships between them as well as describes commonly recurring structure of communicating components that solves a general design problem within a particular context; and (iii) idioms, a low-level pattern specific to a programming language, which describes how to implement particular aspects of components or the relationships between them using the features of a given language. In fact, the term "design pattern" is generally used to refer to any pattern that addresses issues of software architecture, design, or programming implementation[46].

Such level or organization and the own nature of patterns provide many benefits for software development as well as the design of other types of products in different domains. The benefits may include (GAMMA et al., 1996; GAMMA et al., 2002; PRESSMAN, 2009; BUSCHMANN et al., 1996, p. 24):

- they provide a common vocabulary for communication among stakeholders;
- they provide a codified mechanism for documenting problems and their solution in a way that allows the community to capture design knowledge for reuse;
- they act as building blocks from which more complex projects can be built;
- they are already being successfully applied.

4.2 CONTENT OF A PATTERN

Different formats (i.e., standard forms or templates) have been used in the literature for pattern description and, to the best of our knowledge, no single format has achieved widespread acceptance. The original description format used in the Alexander’s work is named “Alexandrian form” or “Canonical Form”. Other formats include Portland, Coplien, GoF and Appleton (FOWLER, 2006).

In all forms, a pattern is written through several elements. Such elements represent characteristics that can be searched (e.g., via a database) so the appropriate pattern can be found

[46] http://www.opengroup.org/public/arch/p4/patterns/patterns.htm

and used (PRESSMAN; MAXIM, 2014, p. 353). Furthermore, to be sure that a pattern covers all the necessary information, mandatory elements must be included, such as pattern name, problem, context, forces, and solution (MESZAROS; DOBLE, 1997). In general, however, the elements described in Table 15 can be found in most pattern templates, even if different headings are used to describe them.

Table 15 - Examples of elements included in patterns forms.

Element	Description
Name	A unique identifier to distinguish the pattern and express its important aspects.
As known as	Other names by which the pattern may be known.
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.
Examples or known uses	Figures, hyperlinks, texts, and other sources to exemplify the final product someone gets when using the pattern.
Consequences	Positive as well as negative consequences that result from the pattern application.
Related patterns	The relationships between a pattern and others within the same context.

Source: Elaborated by the author based on (MESZAROS; DOBLE, 1997).

According to Bergin (2013, p. 2), there are two main categories of pattern formats: (i) explicit meta-data (i.e., using explicit names of elements as section heads), and (ii) implicit meta-data (i.e., using hints, simple typographical, and visual cues rather than explicit names of elements). Novice practitioners are encouraged to start using explicit meta-data.

The content of a pattern can also be dependent of the rules used to organize them into groups, as presented following.

4.3 PATTERN LANGUAGE

The idea of organizing patterns into coherent systems called Pattern Language (PL) was also firstly defined by Christopher Alexander, as stated by (IBA, 2014). From Alexander, Ishikawa and Silverstein (1977), some important characteristics of PLs were defined, for example:

- a pattern language has the structure of a network;
- its patterns are ordered, connected, and presented as a straight linear sequence;
- to use the language, we should begin by the largest patterns and finishing with the smaller ones;
- in general, largest patterns are supported by the smaller;
- since the language is a network, there is no one sequence that perfectly captures it; thus, each person can use a language by his/her own way, by adapting it to his/her preferences and local conditions;
- a large number of smaller languages can be created simply by picking patterns from it;
- for convenience and clarity, each pattern of a pattern language has the same format.

There is no single right way to write patterns and build pattern languages (MESZAROS; DOBLE, 1997). In fact, having the previous original characteristics as a fundamental basis, several authors have proposed guidelines and techniques to enhance the process of writing and validating patterns and pattern languages. Meszaros and Doble (1997), for instance, proposed a pattern language that describes and demonstrates a collection of patterns writing practices. Wellhausen and Fiesser (2011) described a guide for first-time pattern authors. Iba, Sakamoto and Miyake (2011), in turn, presented a procedure for making a pattern language, which summarizes the tacit knowledge of problem solving and problem finding in a certain domain by considering the authors' experience of creating a pattern language for creative learning. In order to systematize the creation of PLs, Braga, Ré and Masiero (2007) also proposed a process that can be used to produce pattern languages for specific domains. In addition, Guerra and Fernandes (2010) proposed an evaluation technique for pattern languages, which can be used for a more rigorous assessment if a pattern or a pattern language as a whole fulfils their objectives.

Although most of the studies previously cited have focused on patterns in the context of software, the resulting knowledge have also been applied in the educational field, as briefly discussed next.

4.4 EDUCATIONAL PATTERNS

Patterns have received much attention in the educational and learning design domains. Despite the use of different terms to define patterns in this context, such as pedagogical patterns (LAURILLARD, 2013), learning patterns (IBA, 2014) as well as instructional design patterns (GOODYEAR, 2005), in our work we refer to them as educational design patterns.

The so called educational 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.g., e-learning), as stated by (MAY; NEUTSZKY-WULFF; ROSTHØJ, 2016). In turn, Goodyear (2005) defined them as a clear articulation of a design problem and a design solution, and offering a rationale which bridges between pedagogical philosophy, research based evidence, and experiential knowledge of design. Furthermore, they can be related to each other and thus offer a toolkit of interrelated design solutions that can be applied to novel problems (e.g., MOOCs).

Considering the use and application of patterns to describe and also to share tacit knowledge from the educational domain, the Pedagogical Patterns Project[47] is among of the more significant references in this area (BERGIN et al., 2012). 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 (BERGIN et al., 2012).

The e-LEN pattern repository also created a collection of patterns but focused on formal e-learning. This project is also completed but the patterns are still available[48]. The collection is organized into four special interest groups: Learning resources and LMS, Lifelong learning, Collaborative learning, and Adaptive learning.

Important contributions on this field have been given by Peter Goodyear and his group, whose research interests include educational design patterns, design for learning, networked learning, analysis and design of complex learning spaces, the nature of professional knowledge

[47] www.pedagogicalpatterns.org
[48] http://www2.tisip.no/E-LEN/patterns_info.php

and professional education, among others (GOODYEAR, 2004, 2005, 2015; CARVALHO; GOODYEAR, 2017).

Iba and his colleagues have also contributed to the educational design patterns area. In (IBA, 2014; IBA; MIYAKE, 2010), for example, they proposed a pattern language that helps learners to achieve a creative learning through the interaction of 40 patterns, which are divided into three main categories: opportunity for learning, learning by creating, and open learning.

Köppe and his colleagues have also made contributions to the educational design patterns. In (KÖPPE, 2013) and (KÖPPE; SCHALKEN-PINKSTER, 2015), for instance, they explored patterns for lecture design and patterns that help with making lectures more interactive. In (KÖPPE et al., 2015), based on several years of experience with flipped classrooms for learning programming in bachelor computing programs, the authors started to collect and describe patterns that help with improving various aspects of Flipped Classrooms.

Laurillard (2013) has a different but complementary perspective, and explores teaching as a design science. According to her, like other design professionals (e.g., architects, engineers, and programmers), teachers have to work out creative and evidence-based ways of improving what they do and, by representing and communicating their best ideas as structured pedagogical patterns, they could develop this vital professional knowledge collectively.

Other related studies were identified by (FIORAVANTI; BARBOSA, 2016), who explored and systematically mapped pedagogical patterns in the context of electronic learning.

Going beyond the application of patterns in the educational field, we explored their usefulness in the specific context of MOOCs, as described next.

4.5 MOOCs and Patterns

There is a rapidly growing interest of institutions and educators in designing and delivering MOOCs either using popular providers, such as Coursera[49], MiríadaX[50], edX[51], and FutureLearn[52], or adapting open platforms to their own infrastructure, such as Google Course Builder[53], open edX[54], the Brazilian instance named Tim Tec[55], among others.

[49] coursera.org
[50] miriadax.net
[51] edx.org
[52] futurelearn.com
[53] edu.google.com/openonline
[54] open.edx.org
[55] timtec.com.br/pt/funcionalidades

Although MOOCs have a lot of potentials, most of the existing courses are still based on traditional classroom formats, which are less effective as a means of learning in this context (FASSBINDER; DELAMARO; BARBOSA, 2014). Furthermore, they are not designed in a way that encourages personalized and self-regulated learning, which are important desirable characteristics for MOOC projects.

This challenging situation has stimulated the development of patterns-based approaches to support educators when designing innovative learning experiences in MOOCs. Furthermore, despite the number of studies that investigated patterns in the educational context, as summarized previously, their use to enhance designing for learning in MOOC requires appropriate adaptations.

Mor and Warburton (2015), for example, 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[56]. In general, the 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 work, conducted by (LACKNER; EBNER; KHALIL, 2015), three design patterns (Four-week MOOCs, Granular certificates, and Suspense peak narratives) are presented as an instructional design claim for MOOCs.

Other three different design patterns, now to promote peer interaction in discussion forums in MOOCs, are presented by (LIYANAGUNAWARDENA; KENNEDY; CUFFE, 2015). They were produced through a series of workshops, which aimed to identify MOOC design principles from the participants' experiences. Such patterns, named Special Interest Discussions, Celebrity Touch, and Look and Engage, contemplate lessons and possible solutions to the problem of creating, managing and facilitating meaningful discussion in MOOCs.

In our work, the Educational Design Pattern Language for MOOCs, proposed as part of the LDF4MOOCs framework, differs from the previous ones since we collected and organized the essential patterns to cover all the main phases of a MOOC design process. We also use Flipped Learning ideas and principles as a pedagogical intervention or pedagogical architecture

[56] http://www.moocdesign.cde.london.ac.uk

for MOOC projects. Furthermore, we particularly focused on the patterns evaluation process, as described in the following chapters.

4.6 SUMMARY

There are different mechanisms to capture and encapsulate knowledge related to learning design, such as theories consisting in a set of design principles, identification of best practices in teaching and learning, and the formalization of knowledge and best practices through patterns and pattern languages (KOPER; TATTERSALL, 2005).

Patterns provide opportunities to represent and share knowledge on learning design in a formal and simple way. McAndrew and Goodyear (2007) consider them as an alternative approach that may have lower barriers to take-up by practitioners, mainly for the novice ones, which is very important in the incipient, but expanding MOOC context.

Despite their potential, patterns-based approaches to help educators when designing innovative learning experiences in MOOCs are still underexplored, as evidenced in this chapter. Also, we presented fundamentals related to patterns and pattern language, as well as the main authors and studies related to them. Such fundamentals provided subsidies for the development of an Educational Design Pattern Language for MOOCs, which act as a learning design strategy to support MOOCs design in the LDF4MOOCs framework.

In the next chapter we describe in detail the LDF4MOOCs framework and its main elements. We present how we connected MOOCs, Learning Design and Software Engineering ideas (i.e., patterns fundamentals) to support the activity of designing for learning in MOOCs, contributing to enhance teaching and learning in the massive, open and online context.

5 A LEARNING DESIGN FRAMEWORK FOR MOOCS

Considering the proliferation of MOOC initiatives, for example different types of MOOCs as well as MOOC providers and open platforms to deliver them, there is a need for a common strategy that can be used to manage and engineer MOOCs. This strategy could be used to reduce barriers to access information and good practices related to the construction of MOOCs as well as foster the next generation of research and development in this field. Besides, it is also an attempt to promote national and international trade in the development and use of MOOCs and related services or tools.

Therefore, in this chapter we discuss the establishment of a learning design framework that can be used by practitioners and technologists when studying, designing or developing MOOCs as well as mechanisms related to them (e.g., virtual learning environments, learning design tools).

According to the Cambridge Dictionary, a framework is a supporting structure around which something can be built[57]. It is also a system of rules, ideas, or beliefs that is used to plan or decide something. A learning design framework, in turn, aims to help teachers/designers make design decisions that are pedagogically effective and make appropriate use of digital technologies (CONOLE, 2014b). According to Bannan (2013), there are thousands of decisions that need to be made in a design context and such type of framework is a step towards the articulation and documentation of common phases and complementary stages based on practice and research processes that promote a more conscious design.

The ideas and solutions embodied in the proposed Learning Design Framework for MOOCs, also called LDF4MOOCs, are mainly grounded on practices of Software Engineering, i.e., systematic and well-defined methods, techniques, and processes. Such practices are embedded in the development of MOOCs aiming at improving quality as well as facilitating reuse and adaptation.

The LDF4MOOCs framework and its main elements are detailed in this chapter. In Section 5.1, we summarize the rationale underpinning our proposal, followed by an overview of the main characteristics and elements of LDF4MOOCs, and how they can be useful for the development of MOOCs. In Section 5.2 we introduce a MOOC Life Cycle that summarizes the

[57] https://dictionary.cambridge.org/dictionary/english/framework.

main phases and activities performed by a team when designing and delivering MOOCs. In Section 5.3 we describe an Educational Design Pattern Language for MOOCs, including the steps performed to collect and formalize its patterns. In Section 5.4 we provide artifacts and tools to support the whole development process of MOOCs by using the framework. Concluding remarks are given in Section 5.5.

5.1 LDF4MOOCs: Overview of the Framework

The proposed framework consists of: (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, that is based on problems and recurring solutions to solve the main activities described in the MOOCs Life Cycle; and (iii) related supporting resources (artifacts and digital tools). The elements are related, and their use together make the framework stronger. However, there is no usage dependency between them. It means they can be used independently, if the users so desire.

The *target audience* of LDF4MOOCs is teachers, learning designers, researchers, technologists, among other people interested in the MOOC development process. However, our focus is small MOOC teams and even single teachers with limited financial, technological, and human resources. We also had the concern of drawing the framework having novice MOOC practitioners in mind.

Regarding the *main roles* related to the proposed framework, the idea is to create means to empower and promote a re-thinking to have: (i) educators as learning designers; (ii) students as active learners; and (iii) virtual platforms as creative spaces to support self and collaborative learning. Firstly, we have chosen educators rather than teachers/instructors to provide a more inclusive term that applies not only to university lecturers, but also to K-12 teachers and vocational/professional trainers. Going beyond, the framework also intends to expand the role of educators by considering them as learning designers, as (LAURILLARD, 2013) also does. In addition, we also adopt leaners rather than students to emphasize attitudes that are expected for MOOC users (SHAPIRO et al., 2017), such as self-regulated learning behaviors, learner motivation, self-confidence, among others.

Considering its *usage*, LDF4MOOCs 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. It can also be used to support research in the context of massive, open and online courses. Moreover, stimulates implications for the activity of educational technologists, especially those involved with the development of MOOC platforms.

Regarding its *applicability*, LDF4MOOCs is written to cover a general MOOC project, about any educational topic. The framework can be adaptable for MOOC projects of different sizes or complexity, although the focus is on small courses (between 4 and 6 weeks). It is also designed to be used to create MOOCs for different MOOC providers and platforms.

In general, the framework *aims to support* practitioners in the development of massive, open and online courses that may be able to *promote* in the individuals the permanent, autonomous, and rapid search for new knowledge, skills development, practice behaviors, positive values, and attitudes, at any stage of their lives. This can also be characterized as a strategy to support lifelong learning. According to Karoudis and Magoulas (2017), learning design methodologies for developing lifelong learning skills are mostly based on constructivist theories and aim to create educational opportunities to develop learners' capacity for self-direction, metacognitive awareness, and a disposition towards lifelong learning.

Regarding the *pedagogical aspects*, LDF4MOOCs draws upon Flipped Learning (BERGMANN; SAMS, 2014; SAMS; BERGMANN, 2013) and active methodologies of teaching and learning as pedagogical strategy. This means that MOOCs created through it will be instigated to use active learning activities, strategies to support self-regulated learning, competency-based learning, among other characteristics

Next, we detail the framework elements, focusing on their main characteristics.

5.1.1 Flipped Learning-Driven Pedagogical Design

The dimensions and characteristics expected for MOOCs, as described in Table 14, introduce new requirements on their pedagogical design. Thus, according to Sergis, Sampson and Pelliccione (2016), the pedagogical model of MOOCs is an important issue to be further studied, especially since certain shortcomings have been attributed to poor pedagogical design, such as the limited learner motivation (ZHENG et al., 2015) and learner engagement (HEW, 2016), and the overall poor instructional quality (COOPER; SAHAMI, 2013; MARGARYAN; BIANCO; LITTLEJOHN, 2015; YUAN; POWELL, 2013).

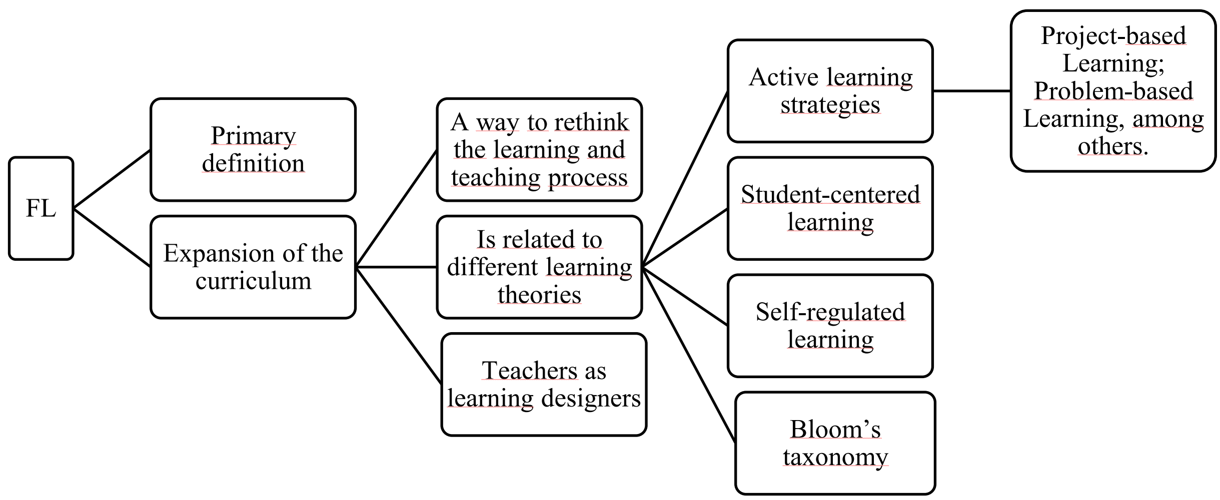
Thus, in this work, we also investigate how Flipped Learning (FL), also known as Flipped Classroom, can be used to act as an intervention to the current design for learning in MOOCs produced through the LDF4MOOCs framework.

FL is an educational strategy that has been applied in formal courses to enhance teaching and learning (BERGMANN; SAMS, 2014; SAMS; BERGMANN, 2013). Its primary definition is based on a simple re-organization of out and in-class learning activities, which could be indeed a possible strategy to apply it. However, as can be identified in (NEWMAN et al., 2014), FL represents an expansion of the curriculum, rather than a mere re-ordering of activities.

Furthermore, according to Galway et al. (2014), FL represents a broader shift in how we think about the learning process. It is grounded on several student-centered learning theories (EPPARD; ROCHDI, 2017). An explicit attention is given to interactive and collaborative learning, based in the works or Piaget, which emphasizes that learning occurs when we act and apply in practice new ideas and learned theoretical concepts. Galway et al. (2014) also point out that, taking into account the influence of (Revised) Bloom's Taxonomy about thinking and learning, the inverted classroom model allows high and low levels of cognitive work. Specifically, students take a lower-order cognitive work, i.e., the acquisition of knowledge, independently, while the higher-order cognitive work, including the application of knowledge, analysis and synthesis, occurs with the support of class friends and teachers.

In addition, FL helps instructors or teachers to develop different learning experiences appropriate for each student, considering their regional or local context (BERGMANN; SAMS, 2014). Thus, since FL incorporates several strategies for engaging students, as previously mentioned and highlighted by Figure 24, our assumption is that such strategies may also provide instructional designers with new ideas for engaging learners even in virtual environments (FASSBINDER; FASSBINDER; BARBOSA, 2015).

Figure 24 - Flipped Learning: definition and related theories.



Source: Elaborated by the author. Adapted from (FASSBINDER et al., 2016).

In our previous studies (FASSBINDER et al., 2016; FASSBINDER; FASSBINDER; BARBOSA, 2015), we investigated how the FL teaching model could be incorporated into MOOC design. A set of design guidelines organized to provide insights and guidance to help MOOC teams to make effective design decisions when creating learning experiences were derived from our previous case studies with FL (FASSBINDER et al., 2014; FASSBINDER; FASSBINDER; BARBOSA, 2015) as well as from relevant literature (HAMDAN et al., 2013; KIM et al., 2014; ROTELLAR; CAIN, 2016), and are presented in Table 16.

Table 16 - 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 by 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	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.
Require 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 thinking 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	Encourage the development of user skills in self-regulation learning. Design of Self-Paced[58] MOOCs.
Use of Active learning approaches in-course.	Project-based learning, Problem-based learning, among other active strategies. 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). Peer discussion 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 in-course activities and out-of-course activities.

[58] The learner can start and complete learning activities at any time and on their own speed.

	Employ the task-oriented environment supported by a well-designed structure that clearly guides students to solve given problems.
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 that are 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.

Source: Elaborated by the author. Adapted from (FASSBINDER et al., 2016).

Considering Figure 24 and Table 16, it is possible to identify basic tasks or activities that MOOCs teams should to carry out to design and deliver a course based on 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 relationships can be formalized or described using educational design patterns and pattern languages (MCANDREW; GOODYEAR, 2007), as presented in Section 5.3.

Following we present a Life Cycle Process for MOOCs, including the use of Flipped Learning ideas as an intervention to enhance the current pedagogical design in this context.

5.2 MOOC LIFE CYCLE PROCESS

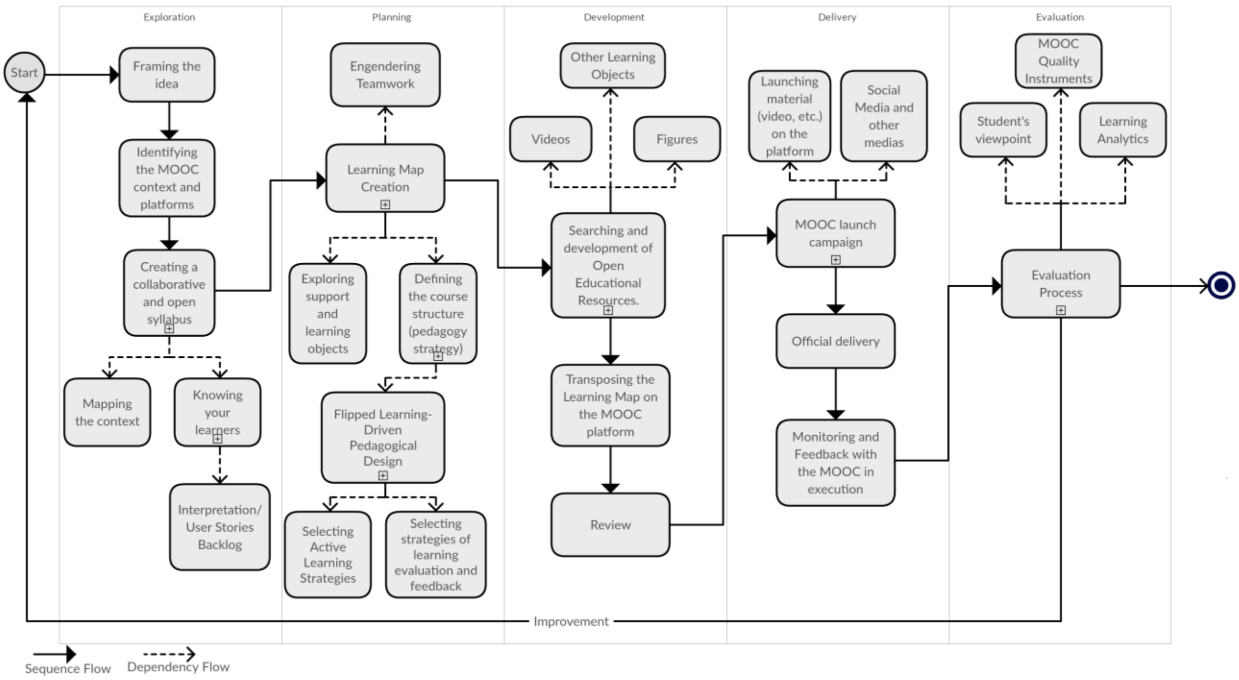
Aiming to move towards the exploration of a common structure to support educators, learning designers, technologists and institutions involved with the MOOC development and maintenance, a MOOC Life Cycle was proposed. Its current version is shown in Figure 25 but its refinement and evolution process is detailed in (FASSBINDER et al., 2016; FASSBINDER; BARBOSA; MAGOULAS, 2017a).

A process is an organized set of activities and procedures generating a specific result, and a life cycle prescribes a set of structured phases for achieving this result (ARIMOTO, 2016, pp. 88). Moreover, in general, ISO/IEC 12207 defines the structure of a life cycle process in terms of activities further designed in terms of its constituent tasks, where a task is a set of basic or atomic actions that consumes inputs and produce outputs.

The proposed life cycle process is embodied in a set of actions informed by commonly linked and complementary theories from the perspective of learning design, education and technology to support teaching and learning practices in MOOCs, such as the ADDIE model (MOLENDA, 2003), i.e., a generic design process commonly used by learning practitioners.

The life cycle process is responsive to the speedily evolving MOOC concept. The scheme achieves this by providing a top-level overview of the life cycle of MOOCs where phases, activities, and tasks are "what-to-do" items, not a "how-to-to" method. A way of "how-to-do" is the role of the Pattern Language described later.

Figure 25 - A Life Cycle Process for MOOCs.



Source: Elaborated by the author.

The MOOC life cycle process is divided into five phases, as summarized next.

5.2.1 Exploration

During the *Exploration phase*, the MOOC team needs to clarify the main goal of the MOOC project. It is important to identify the institution needs and how will the MOOC contribute to the institution's mission. Funding matters are also approached in this phase. The platform that will be used to deliver the MOOC is defined.

It is also important to define the teaching/learning challenge by diving into the context and the course audience. Personas may be identified. They are fictional characters that represent a target public. Designers use personas to obtain a detailed description of the typical user in a context, such as their needs, details, preferences, motivations, and other characteristics that should influence design (COHN, 2004). According to (FASSBINDER; DELAMARO; BARBOSA, 2014), in learning, the increasing abundance of quality content will shift the attention from content to experience. Because good learning content will be available from many sources, learners will be more selective based not so much on content but on learning experience. This is where personas can help. 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 an e-learning project, user stories (COHN, 2004) will describe what the learner is able to do in the course, which creates a connection between the learning goals and the course approach. User stories can also be used to structure the content in a way that it is personal for the user, impacting how effective the solution will be and achieving personalized learning (ARIMOTO; BARROCA; BARBOSA, 2016).

5.2.2 Planning

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 activities, and develop the MOOC Learning Map. According to Filatro (2008), a Learning Map, also named 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 aims to present an overview of the dynamics of the learning in the course.

Considering the MOOC life cycle process (Figure 25), the pedagogical design of the course must be defined in the *Planning phase*. In this work, it is driven by the Flipped Learning model, as described in Section 5.1. Flipped Learning is 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-regulated learning. The model is 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 MOOC Learning Map.

5.2.3 Development

During the *Development phase*, the MOOC Learning Map created during the planning phase is implemented using some MOOC provider (e.g. Coursera, Veduca, FutureLearn, among others) or a MOOC open platform (e.g., Tim Tec, Google Course Builder, and open edX). It requires the search or the development of learning content, such as Open Educational Resources (e.g., videos, figures, games, open textbooks). According to Arimoto (2016, p. 128), the Internet provides facilities for seeking online contents through different mechanisms, such as specialized search engine (e.g., Open Courseware Consortium[59]), institutional repositories (e.g., OpenLearn[60]), digital libraries (e.g., OER Commons[61]), general search engine (e.g., Google Search), and many others. However, when searching for and selecting contents, some issues should be considered: (i) learning contents accessibility; (ii) different search engines, databases and repositories; and (iii) awareness on the licensing types used on the available learning contents (ARIMOTO, 2016, p. 128). In addition, before MOOC reaches hundreds of learners, it is important to improve the course by using reviewing and testing strategies.

5.2.4 Delivery

The *Delivery phase* consists in open the course for enrollment and running the MOOC. Once the MOOC landing page is published, leaners can find the course and enroll. Although many learners discover MOOCs through organic search, strategic marketing by the institution can significantly increase traffic and enrollments.

Once learners joined the new course, welcome emails and weekly announcements can be used to keep them engaged, explain course material, deadlines, among other peculiarities. Monitoring and feedback with the MOOC in execution is fundamental to create a strong sense

[59] ocwconsortium.org
[60] openlearn.open.ac.uk
[61] oercommons.org

of community and improve leaners' outcomes. Tensions and conflicts that arise in forums should be addressed by turning them into learning opportunities.

5.2.5 Evaluation and Improvement

The *Evaluation and Improvement phase* can be performed during all phases of the MOOC Life Cycle Process. For example, the MOOC can be tested by using quality assurance methods formulated by specialists or guidelines specified by the MOOC platform or the MOOC team' institution. It is also important to collect and analyze feedback from learners in several ways (e.g., pools, posts in forums, electronic questionnaires) to promote improvement in the new versions of the course.

Major updates and changes must be done to new versions of the MOOC. It is also important to define the status of the MOOC after each launching has been completed, which may depend on the used platform. The Coursera MOOC platform, for instance, defines that versions can have the following status[62]: (i) *original*: the first launched version; (ii) *archived*: versions that are no longer live in any active sessions; (iii) *live*: versions that are live in one or more active session; (iv) *upcoming*: a launched version that will be open for registration very soon; and (v) *new*: versions that have been created, but haven't launched yet.

5.3 AN EDUCATIONAL DESIGN PATTERN LANGUAGE FOR MOOCS

The design of innovative and disruptive MOOCs has been a difficult task for practitioners, especially novices, since well-known methodological design strategies and desirable characteristics for MOOC projects are still underexplored (HEW; CHEUNG, 2014; SERGIS; SAMPSON; PELLICCIONE, 2016). Design patterns and pattern languages attempt to mitigate this situation by providing instructors and MOOC teams with empirical theory-driven practices that could help them to enhance the course quality.

Patterns have received much attention in several areas due to their potential to act as a simple way to describe and share tacit knowledge and support new product development. Despite their notable applications in architectural design (ALEXANDER; ISHIKAWA; SILVERSTEIN, 1977) and software development (GAMMA et al., 2002), challenging situations have also stimulated the development of patterns-based approaches to support

[62] The material is only available for Coursera partners in https://partner.coursera.help/hc/en-us/articles/115000170006.

educators when designing innovative learning experiences in MOOCs (WARBURTON; MOR, 2015).

However, according to previous studies (FASSBINDER; DELAMARO; BARBOSA, 2014), current approaches face some limitations. For example: (i) they do not focus on the entire design process; (ii) MOOC teams are still using ad hoc decision-making procedures, institutional or MOOC providers' guidelines to design for learning; and (iii) they are not pedagogically informed, or the pedagogical approach used tends to be content-based and teacher-centered.

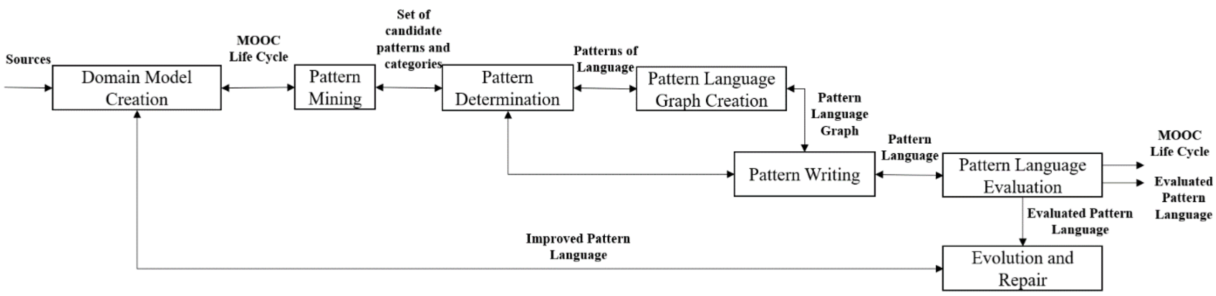
In this context, the core element of the LDF4MOOCs framework is a MOOC design approach based on educational design patterns. Therefore, this section describes a Pattern Language (PL) to support design for learning in MOOCs. The section itself is grounded on the main studies we already published about the language (FASSBINDER; BARBOSA; MAGOULAS, 2017a, 2017b).

Firstly, the development method of the pattern language is presented. Then, all the corresponding patterns are briefly presented in the form of patlets (problem-solution pair), and two patterns, called Learning Map Creation and Flipped Learning-Driven Pedagogical Design, are detailed. All the patterns are also available online at caed.icmc.usp.br/mooc.

5.3.1 Development Method

Our approach for the PL development is a mixture of procedures defined by (BRAGA; RÉ; MASIERO, 2007), (IBA; SAKAMOTO; MIYAKE, 2011) and (MESZAROS; DOBLE, 1997), and encompasses seven main phases, as summarized in Figure 26. Although the PL development method appears to be sequential, it is based on an iterative and incremental flow.

Figure 26 - The PL development process.



Source: Elaborated by the author. Adapted from (BRAGA; RÉ; MASIERO, 2007; FASSBINDER; BARBOSA; MAGOULAS, 2017b).

- *Domain Model Creation*. According to Braga, Ré and Masiero (2007), patterns are usually documented based on practice. To build a PL that covers applications in certain context is necessary to observe and collect solutions that are commonly employed to solve recurring problems in a given domain. Thus, the first phase is to explore the acts of experts in the community and identify the key activities commonly performed by MOOC teams when developing MOOCs. Such activities were firstly identified from five main sources: (i) review of strategies to design and develop MOOCs; (ii) guidelines shared by MOOC providers; (iii) MOOC guidelines from Universities/Educational Institutions; (iv) survey of MOOC practitioners; and (v) our own experience designing and delivering MOOCs.

After collecting the activities, the next step was to organize them by compiling similar ideas, diving into categories of activities, giving names to the groups, and connecting each other according to their meaning. As a result, we defined a model, named MOOC Life Cycle Process, that captures the activities presented in the majority of the MOOC development processes analyzed. The life cycle also summarizes a set of design steps that can be applied systematically, with the aim to ensure a degree of quality in the design of MOOCs (FASSBINDER et al., 2016), as described in the previous section.

- *Pattern Mining*. The 'blueprint' resulting from the previous phase helped us to identify the acts of experts and then understand the knack of the acts. According to Iba, Sakamoto and Miyake (2011), the extracted knacks are potential ideas for patterns, also named candidate patterns or proto-patterns. The corresponding problem to the solution may be related to the design activities presented in the domain model. The first patterns core elements were described as name, context, problem, and solution. The candidate patterns were also grouped into "families of patterns" that shared certain design goals. The groups represent key phases of the MOOC Life Cycle Process (Figure 25).
- *Pattern Determination.* The MOOC Life Cycle Process and the set of candidate patterns resulting from the previous phases were used to identify more patterns, refine the current ones, and guide the Pattern Language Graph creation (Figure 27). We also designed and delivered three MOOCs (Fassbinder et al., 2016; 2017a) to validate the already obtained patterns, find new patterns, and improve their description. In addition, we also explored educational patterns discovered by other related studies, which were identified by a systematic mapping conducted in our research group (FIORAVANTI; BARBOSA, 2016). Some patterns were adapted to the MOOC context and others were recognized as similar patterns. Similar patterns, in this context, are patterns published by other authors; they may have different names but have the same meaning or treat the same problem.

- *Pattern Language Graph Creation*. In this phase, a graph was defined to show the interaction between the patterns or the patterns application flow. The related graph is described in Figure 27.
- *Pattern Writing*. Once the Pattern Language Graph was created, the "related patterns" of each pattern were updated in order to support the flow definition in which the patterns are used or applied to design a MOOC. According to Meszaros and Doble (1997), "related patterns" are other patterns that may be of interest to the reader, such as other solutions to the problem, more general or specific variations of the pattern, and patterns that solve some of the problems in the resulting context. The final patterns format was also defined by considering a specific pattern language for pattern writing described in (MESZAROS; DOBLE, 1997) and the format used by (IBA, 2014). Each pattern was described using the template (Table 17):

Table 17 – Pattern Template.

Field	Description
Name	A unique identifier to distinguish the pattern.
One-liners	A brief explanation of the pattern.
Illustration[63]	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	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. In the proposed language, examples are optional.
Related Patterns	In our context, they are cited when needed, within the pattern description itself (e.g., solution field).

Source: Elaborated by the author.

- *Pattern Language Evaluation.* According to Goodyear et al. (2004), development, evaluation, and dissemination of design patterns and pattern languages are collaborative activities, usually extending over several years. Besides, Braga, Ré and Masiero (2007) highlight that a complete evaluation of a PL is a difficult task because many applications are required to guarantee its usefulness. Abraham (2008) also highlights that, despite the popularity

[63] All the illustrations used in the proposed patterns are available on Google Imagens and have license for reuse.

of patterns, there is a lack of empirical studies evaluating when a shared understanding through patterns is valid. Guerra and Fernandes (2010), for example, highlight that the “rule of three” (KOHLS; PANKE, 2010), which determines that a pattern should have at least three known uses, is not enough for the validation of the design knowledge identified through patterns and pattern languages. In this context, to evaluate a Pattern Language they proposed an evaluation process that can be used for a more rigorous assessment if a pattern or a pattern language as a whole fulfills their objectives.

To support the evaluation phase, Goodyear et al. (2004) and Braga, Ré and Masiero (2007) suggest the use of online tools, such as wikis, and conferences, for example the Pattern Languages of Programs (PLoP[64]), which undergo rigorous “shepherding strategies” before and during the face-to-face meeting. Abraham (2008) suggests the use of controlled studies with expert designers and users; and proposes the evaluation of a PL considering four criteria: cohesiveness, generativity, design guidance, and coherence.

In the context of this work, a mix of strategies was used to evaluate the MOOC Life Cycle Process and mainly the Pattern Language: (i) empirical studies and experts review as internal evaluation methods; and (ii) a field evaluation with educators using the PL as a guide to develop their MOOCs was considered as an external evaluation method to confirm usability, satisfaction, trustworthiness, and educational effects. The evaluation methods are described on Chapter 6.

- *Evolution and Repair.* Applying and evaluating the language provides the necessary feedback to promote the continuous development of its patterns. It is also important to observe how these patterns interact in practice. To facilitate the improvement of our pattern language, a web tool to support the management of the patterns and the PL itself was developed. Its main purpose is to act as a way to motivate patterns dissemination, their improvement, and collaborative work between practitioners. The tool is described in detail in Section 5.4.

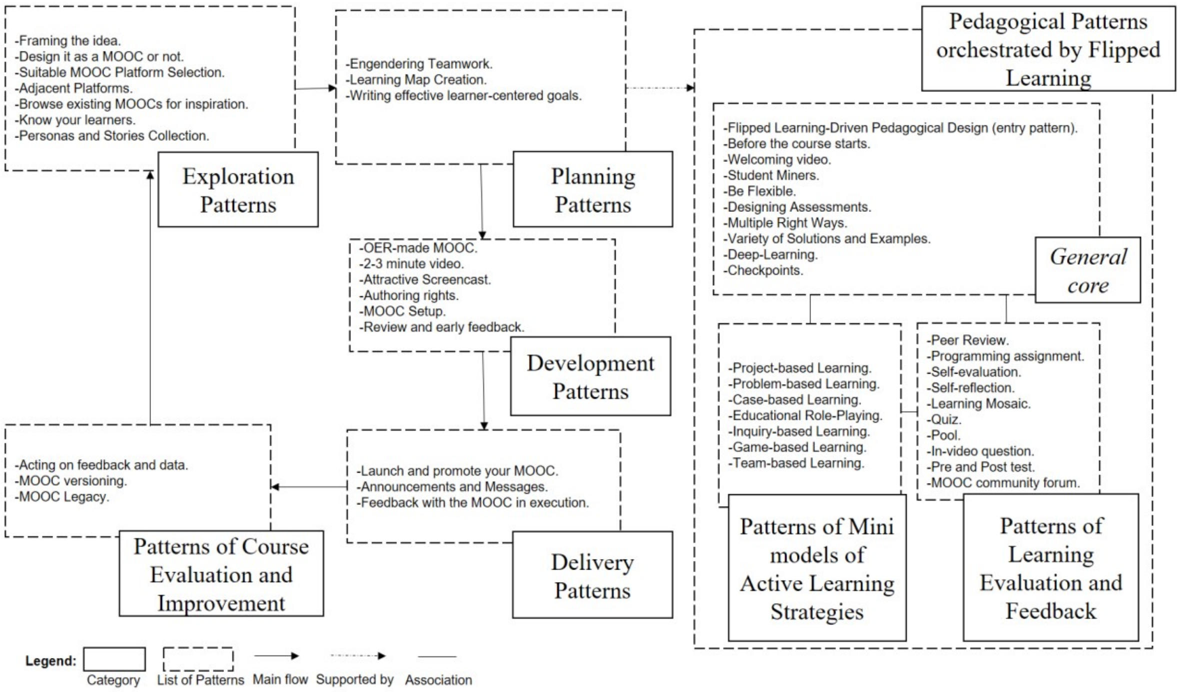
5.3.2 Overview of the Educational Design Pattern Language for MOOCs

The PL suits novices and experienced MOOC practitioners. Novices may choose to use patterns as suggestions to be tried and adopted, while experts can use them as a form of validation, helping them to incorporate in their designs some of the desirable characteristics for MOOCs. Figure 27 presents the PL related graph.

---

[64] www.hillside.net/plop

Figure 27 - Educational Design Pattern Language graph.



Source: Elaborated by the author. Adapted from (FASSBINDER; BARBOSA; MAGOULAS, 2017b).

A brief description of the related patterns, in the form of patlets (problem-solution pair), is presented next. They are grouped into eight categories (FASSBINDER; BARBOSA; MAGOULAS, 2017b). It is important to notice that patterns' names are described using the COPPERPLATE GOTHIC LIGHT font, while categories of patterns use the same font, but are UNDERLINED.

Exploration. Table 18 presents the set of patterns approached by the *Exploration Phase*.

Table 18 - 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 "*Instrument to*

	Support the Evaluation of Learning Maps in the MOOC Context (Appendix C)". 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; MOR, 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; MOR, 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.

Source: Elaborated by the author.

Planning Patterns. Table 19 presents a set of patterns to support the *Planning Phase*.

Table 19 - Set of patterns to guide the Planning Phase.

Pattern Name	Brief Description (problem-solution pair)
ENGENDERING TEAMWORK Adapted version from TEAM WORK by (WARBURTON; MOR, 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.

Source: Elaborated by the author.

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 of the team.

As a top-level pedagogical strategy, we consider the use of Flipped Learning ideas adapted to the massive, open and online context. The point is understanding Flipped Learning as a framework that is based on several theories which help the MOOC team to scrutinize the use of diverse sets of characteristics required for MOOCs (DESIGN IT AS A MOOC OR NOT) and PATTERNS OF MINI MODELS OF ACTIVE LEARNING STRATEGIES. Table 20 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 20 - 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; MOR, 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; SCHALKEN-PINKSTER, 2015)	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; MOR, 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; MOR, 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; MOR, 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.

Source: Elaborated by the author.

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 21 summarizes a set of patterns to support the use of active learning strategies in the MOOC context.

Table 21 - 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. The full version of these patterns describes 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	

Source: Elaborated by the author.

Patterns of Learning Evaluation and Feedback. It concerns to different evaluation strategies that can be adapted to the MOOC context. Patterns summarized in Table 22 should be used during the *Planning Phase* in order to integrate the LEARNING MAP CREATION.

Table 22 - 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. The full version of these patterns describes 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	

Source: Elaborated by the author.

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, FutureLearn) or a MOOC open platform (e.g. Tim Tec, Google Course Builder, open edX). We also need 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 23. 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); and (c) transferring the Learning Map and its related resources (e.g. videos, images) to the chosen MOOC platform.

Table 23 - Set of patterns to support MOOC Development Phase.

Pattern Name	Brief Description (problem-solution pair)
OER-MADE MOOC	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

Similar to SCAFFOLDED MOOC by (WARBURTON; MOR, 2015)	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; MOR, 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; 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 enrol 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.

Source: Elaborated by the author.

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 24 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 24 - 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; MOR, 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."

Source: Elaborated by the author.

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. Table 25 summarizes the main related patterns.

Table 25 - 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 analyse 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; MOR, 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.

Source: Elaborated by the author.

5.3.3 Describing Some Specific Patterns

In this subsection, two specific patterns are detailed. The other patterns are available online at http://caed.icmc.usp.br/mooc, as previously highlighted.

The LEARNING MAP CREATION pattern was, in fact, adapted for the MOOC context, but has been common used in many learning design situations (e.g., 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.

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 the following table, 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 – 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.

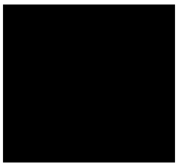
Finally, you should define the teaching strategies and the sequence of learning activities.

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 "*Instrument to Support the Evaluation of Learning Maps in the MOOC Context* (Appendix C)" 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 massive, open and online 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. 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. The following table summarizes the main ideas and elements behind this pattern:

Table - 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

5.4 SUPPORTING RESOURCES

The need for artifacts and tools to support specific activities in the development of MOOCs also emerged during the refinement of the framework: (i) a template of Learning Map; (ii) an *Instrument to Support the Evaluation of Learning Maps in the MOOC Context* (Appendix C); and (iii) the framework's website.

Some resources were adapted for the MOOC context, such as the Learning Map template, but others were created specifically to meet the MOOC development needs and are now an essential part of the framework. Digital tools were created to support practitioners in the main activities of the MOOCs development and also correlated practices, such as patterns management. Such tools are part of studies derived from this work and their development was supervised by the author of this thesis.

5.4.1 Learning Map Template

A Learning Map (also named Activities Map, Instructional Design Matrix or Course Design Matrix) is a learning design document that acts as a roadmap for learning designers, being usually created during the planning phase of an educational design process (i.e., a course, a workshop, a module, educational resources) (ROYTEK, 2010). It generally contains the organization of activities and the learning outcomes to be achieved by the students.

The map can be organized in a table, which aims to present an overview of the dynamics of the learning in the course. According to Martin (2011), this design document might include all or some of the following components: (i) the learning goal(s) in different levels (e.g., course and activities); (ii) educational material to support the achievement of the goals; (iii) teaching and learning activities; (iv) feedback for the activities; (v) assessment activities aligned with learning goals; (vi) instructional media/technology/platforms; and (vii) pedagogical strategies. Still considering Martin (2011), using this matrix model in the learning design process saves time and makes the material more effective compared to just using top-down approaches (e.g., lessons plans).

In this work we propose an adaptation of the Learning Map concept, originated described in (FILATRO, 2008; FRANCO, L.; BRAGA, D; RODRIGUES, 2010), to be used in the MOOC context. The artifact is also the main outcome of the *Planning phase*.

An example of Learning Map template is presented in Table 26. Good practices to use Learning Maps in the context of MOOCs were encapsulated into the specific pattern LEARNING

MAP CREATION. Examples of Learning Maps are presented in Chapter 6, considering case studies about MOOCs developed for this work.

Table 26 - Example of a Learning Map template.

MOOC Platform: Course Name: Content: General goal(s): Minimum Requirements (if applicable) Pedagogical Strategy(ies): Facilitator: MOOC Team:					
Module or week identification (number and/or title)	Brief description	SubModules or SubUnits	Learning goals	Adjacent Platforms (e.g. Facebook group, etc.) If applicable	MOOC Platform Activities

Source: Elaborated by the author. Adapted from (FRANCO, L.; BRAGA, D; RODRIGUES, 2010).

5.4.2 A Strategy to Support the Evaluation of Learning Maps in the MOOC Context

Validated instruments and tools that help MOOC teams, mainly instructors and learning designers, when verifying the quality of the project and the adherence between their Learning Maps and characteristics desirable for MOOCs have been little explored by the community.

Therefore, another contribution of this work was the development of an instrument suitable to evaluate Learning Maps for MOOCs. This artifact can be used by MOOC teams, mainly instructors and learning designers, as a guide to develop Learning Maps and to validate its final version before start recording videos and developing other learning objects for the course.

The instrument is also a way to motivate practitioners to think and act as learning designers, in order to develop competences based on reflective practice in education, as instigated by (LAURILLARD, 2013). Teachers can use this approach in a deeper process based on design, test, analysis, redesign, re-test and so on, with the purpose of trying to understand how to improve the design of teaching in MOOCs.

Educational Design Research (ANDERSON; SHATTUCK, 2012; MCKENNEY; REEVES, 2012; NIEVEEN, 2009) was used as a theoretical foundation during the instrument development process. The context was identified, and the problem was defined considering the systematic mapping presented in Chapter 2. This review was also used to identify MOOC indicators and characteristics to be considered by instructors when designing for learning in MOOCs, which are presented in Section 3.3. Controlled experiments were performed as a strategy for internal validity. In addition, we designed and delivered MOOCs in the context of Computer Science and Software Engineering using the proposed instrument as a support to validate the course's projects. For external validity, we also applied a survey with specialists who conducted MOOCs. Some of them validated usability and applicability of the proposed instrument. Others used the instrument to plan and evaluate Learning Maps of their own MOOCs. Related evaluation results are described in the Chapter 6.

Appendix C presents the instrument. It contains 35 indicators grouped along eight dimensions. Such dimensions are represented in Table 27. The dimensions and their indicators represent desirable characteristics that should be considered by instructors when designing a Learning Map in the context of open and online courses.

For each indicator, the MOOC team has to check to what extent their Maps contemplate such items. The answers are based on the format of a typical five-level Likert item (1- does not contemplate; 5- fully contemplates). This type of instrument and quality analysis of learning projects for MOOCs can also contribute and guide the development of new MOOCs platforms and authoring tools to support automated evaluation of quality and usability of MOOCs considering desirable characteristics.

Table 27 - Dimensions of desired characteristics for MOOC Learning Maps.

Dimensions	Description
(1) Competency-based design	The MOOC project encompasses the development of personal and professional competences by using active learning strategies, for example; Activity-based instruction is more used than Content-based instruction.
(2) User-centered learning	The MOOC project promotes learner empowerment and engagement through student-centered approaches; Leaners'

	characteristics and needs are contemplated; Ways to learn are flexible and personalized.
(3) Self-Regulation learning	The MOOC project contemplates strategies to support Self-regulated Learning.
(4) Social Networking and Collaborative Learning	The project uses strategies that encourage collaborative learning more than the individual study; also uses tools that promotes social interaction and frequent contact between the participants, such as hashtags, groups, lists, among others; provides opportunities for the creation of small groups of discussion based on common interests, culture, geographical location, and language.
(5) Deep Learning, knowledge creation and sharing	The project includes activities that stimulate the development of higher order thinking skills (Bloom's Taxonomy), such as drawing, building, programming, critiquing, experimenting, moderating, comparing, organizing, among others; encourages students to use digital technologies to create and share their own content through blogs, videos, texts; also contemplates actions that encourage participants to continue discussions and learning even after the end of the course so that they can act as agents of transformation in their own contexts.
(6) Assessment and Understanding	The project uses self-assessments based on clear objectives and criteria; uses authentic evaluations, based on real contexts; the proposed activities are more divergent than convergent, i.e., questions can be answered in different ways and considering several options. Contemplates a greater number of formative evaluations than summative.
(7) Accommodate differences	The course project if designed to accommodate as many differences as possible, for example

	learners with different backgrounds, previous experiences, learning objectives, and disabilities; the project uses different media to capture and retain learners' attention, such as videos, texts, e-books, movies, games, simulators, among others.
(8) Feedback	The project provides different opportunities and types of feedback for the students through instructors, pairs, and automatic, i.e., from the system.

Source: Elaborated by the author.

To facilitate the use of this instrument (Appendix C), a related web tool was developed by a student from IFSULDEMINAS (Campus Muzambinho) during her traineeship in the *Laboratório de Tecnologias de Software e Computação Aplicada à Educação* (LabSoft[65]), under the supervision of this Ph.D. Candidate. The tool is already available for use[66] and can be accessed through http://labsoft.muz.ifsuldeminas.edu.br/projetos/validacao/. Related results are presented in (SILVA; BARBOSA; FASSBINDER, 2017).

5.4.3 The Framework's Website

A website was created to disseminate the doctorate project and provide the framework for all. It is available at http://caed.icmc.usp.br/mooc.

As a proxy indicator of the framework's growth and dissemination, from October 2016 to June 2018, the website had 289 visitors (66% new visitors, 34% returning visitors), 5.632 page views (i.e., the total number of pages viewed) from 10 different countries (Brazil, United States, United Kingdom, Portugal, Netherlands, Argentina, Chile, Germany, Spain, France, and Greece).

5.5 SUMMARY

In this chapter we presented LDF4MOOCs, a framework to support the design for learning in MOOCs. The framework aggregates three main elements: (i) a MOOC life cycle process, which describes what should be done to plan, offer and evaluate a MOOC; (ii) an

[65] labsoft.muz.ifsuldeminas.edu.br/

[66] The demo credentials are login: teste@teste.com and password teste.

Educational Design Pattern Language for MOOCs, which describes solutions about how to design a MOOC for learning; and (iii) related supporting resources (artifacts and digital tools).

The LDF4MOOCs framework differs from other strategies to design for learning in MOOCs in several aspects: (i) it focuses on the entire MOOC design process; (ii) it is pedagogically informed by Flipped Learning ideas and fundamentals, which act as an effective intervention to support learning in MOOCs, helping learners to take the active role in their own acquisition process of skills and knowledge construction; (iii) it is ground on Software Engineering mechanisms and systematic procedures to ensure the standardization and the productivity of all the aspects involved in the MOOC development process, and to meet the desired quality of the resulting materials; and (iv) it differs from other approaches which have been developed to support MOOC design since the framework and its main elements were validated by an iterative process that contemplates different methods to investigate the effects of using LDF4MOOCs under different stakeholders' viewpoint.

The next chapter presents the methods used to validate LDF4MOOCs and its elements. They were evaluated through empirical studies and experts review as internal evaluation methods. A field evaluation with educators using the framework to design MOOCs was also considered as an external evaluation method.

6 EVALUATION AND RESULTS

This chapter presents the methods used to evaluate and refine the framework. Such methods were performed during the whole framework's development cycle, as recommended for studies based on the Educational Design Research (ANDERSON; SHATTUCK, 2012; MCKENNEY; REEVES, 2012; NIEVEEN, 2009). In general, the methods are associated with formative evaluation within the context of instructional design. As suggested by Vesper, Reeves and Herrington (2011, p. 2), the purpose of formative evaluation during educational design research is to provide the design team with the information required to make decisions and take the appropriate actions to refine or improve the prototype learning solution.

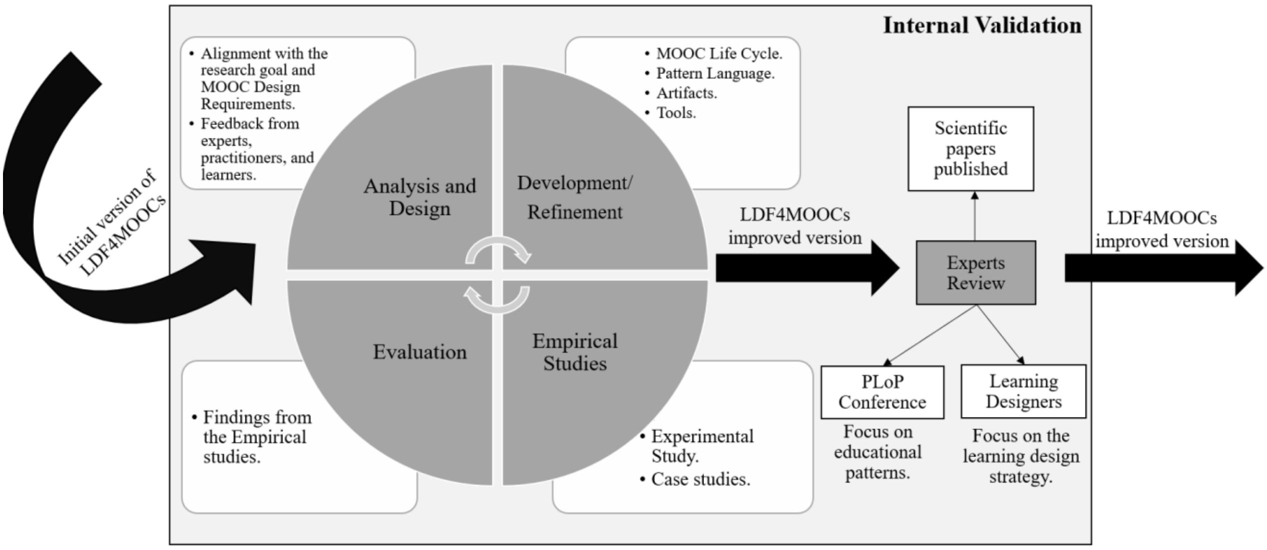
The following sections are grounded on (SPECTOR; MERRILL, 2005, pp. 208; TRACEY, 2009; ABRAMI; BERNARD, 2006), which have focused on systematically studying the processes involved in the development and validation of learning design strategies. According to them, systematic validations include expert review, usability documentation, field evaluation, and controlled testing, among others.

Internal validation focuses on the integrity of a given strategy, is commonly conducted during its development, and can be understood as a formative evaluation of such strategy (SPECTOR; MERRILL, 2005, pp. 211). In our work, the following questions guided the internal validation: Are all the elements of LDF4MOOCs necessary? Considering the MOOC Life Cycle Process, are all steps included in the cycle necessary? Are there any steps missing? The same questions can also be applied for the Educational Design Pattern Language; for example, are all patterns and categories included in the language necessary? Are there any patterns that need to be clarified? To what extent does the framework address the desirable characteristics for MOOC design in order to support instructors and learning in the massive, open and online context?

While concerns about the credibility of the conclusions focus on the internal validity of an investigation, the concerns about the applicability of the conclusions focus on the external validity (ABRAMI; BERNARD, 2006). *External validation* of learning design strategies addresses the effects of using a framework, its elements (e.g., MOOC Life Cycle, Educational Pattern Language, and related artifacts and tools), the resulting products (e.g., a MOOC Learning Map and the MOOC itself), and the impact of such elements and products on users, such as learners, instructors, and learning designers (SPECTOR; MERRILL, 2005, pp. 208). External validity can never be fully achieved, but strong validation strategies can contribute to truthful and widely usable research results (ABRAMI; BERNARD, 2006). To externally validate a learning design strategy, some authors suggest the use of field evaluation, survey, and controlled testing (SPECTOR; MERRILL, 2005, pp. 215).

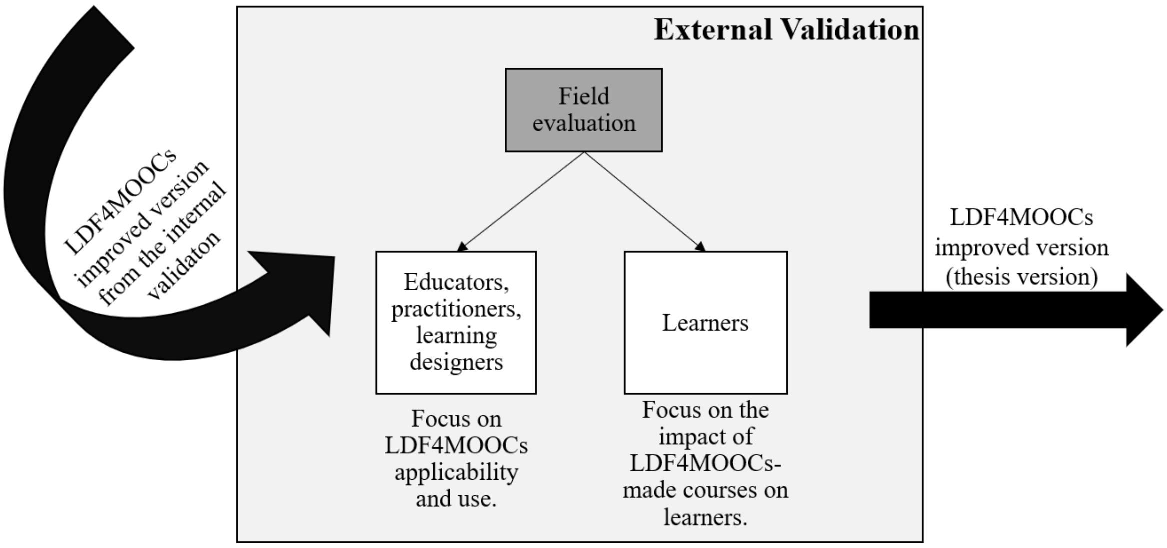
In this work, LDF4MOOCs and its elements were evaluated through an experimental study, case studies, and experts review as internal evaluation methods. A field evaluation with educators using the framework as a guide to design their MOOCs was considered as an external evaluation method to confirm usability, satisfaction, trustworthiness, and educational effects on leaners. It is worth noting that no single strategy has a complete advantage over all the others. In fact, the various evaluation methods are highly complementary; for our work we decided to use as many sources of evidence as possible. An overview of the evaluation process performed is summarized in figures 28 and 29.

Figure 28 – LDF4MOOCs internal validation process.



Source: Elaborated by the author.

Figure 29 – LDF4MOOCs external validation process.



Source: Elaborated by the author.

The remainder of this chapter is structured as follows. Section 6.1 describes the experimental study conducted. Section 6.2 explores the case studies performed. Section 6.3 presents one experts review with focus on the educational patterns and pattern language, and one experts review conducted with learner designers with focus on the proposed LDF4MOOCs framework. The field evaluation is described in Section 6.4. Concluding remarks are presented in Section 6.5.

6.1 Experimental Study

Motivated by the need of investigating the effect of LDF4MOOCs with respect to the adherence of MOOC Learning Maps created through it and the desirable characteristics for MOOCs, with focus on the exploration and planning phases of the MOOC Life Cycle, an experimental study was performed. According to Wohlin et al. (2012), an experiment is an empiric enquiry used to manipulates one factor or variable of the studied setting, where treatments are applied to or by different subjects, while keeping other variables constant, and measuring the effects on outcome variables.

Such study was also used to understand the differences and the changes between MOOC Learning Maps developed using an ad hoc basis and those created through a specific learning design strategy for MOOCs, as the proposed LDF4MOOCs. Furthermore, it was also used to formatively evaluate the framework through an empirical and iterative way, as well as plan further research activities, since it was performed in three steps, covering mainly the middle part of the framework development process.

This section describes the experimental study involving the use of the LDF4MOOCs framework by novice MOOC practitioners. The study was guided by (WOHLIN et al., 2012) and (COBB et al., 2003), on which the theoretical aspects of this section are also grounded.

6.1.1 Scope and Study Design

This experimental study was conducted in the form of workshops, during academic weeks of computer courses in three different public Brazilian universities, from September 2016 up to May 2017, but having the same experimental design, as described as follows. Such workshops[67], named "Development of Learning Maps for MOOCs", were open for free, to people from the Computer Science area and other fields interested in the subject. They were also a way to share our research with the community.

Each workshop lasted four hours and the participants had the choice of working in pairs or individually. To minimize the effect of "experience" of the participants, in the first two hours they had to develop a MOOC Learning Map on an ad hoc basis. In the second part, the participants had to create a new Learning Map but considering a different topic, and by using the proposed LDF4MOOCs. In both cases, the participants had to choose topics on which they had certain knowledge and that would leave them comfortable and motivated to plan a course.

The participants used a same specific rubric, based on the *Instrument to Support the Evaluation of Learning Maps in the MOOC Context* (Appendix C), to self-evaluate the effect of the approaches (i.e., ad hoc versus LDF4MOOCs) on MOOC Learning Maps, with respect to the adherence of the maps and the desirable characteristics for MOOCs, which are approached by the instrument. In fact, the rubric was used two times. First to measure the effects of the use of the ad hoc method to create a MOOC Learning Map, and then to verify the map created through the LDF4MOOCs. Both evaluations considered the score of compliance to the desirable characteristics for MOOCs described in the instrument.

The scope of an experiment, according to Wohlin et al. (2012, p. 85), characterizes its goals and can be described using well-known structures that help to identify, in advance, important aspects to be considered before running it. Thus, the *objects* considered in the experimental studies were the ad hoc and the LDF4MOOCs approaches. In a more detailed

[67] Website: https://sites.google.com/view/moocbr/oficinas?authuser=0

dimension, the objects were the MOOC Learning Maps built using the both approaches. The *purpose* was to evaluate the LDF4MOOCs framework, in particular with respect to the effect of using it to design MOOC Learning Maps. The *quality focus* was the effectiveness of LDF4MOOCs in the MOOC Learning Map development, i.e., the degree to which something is successful in producing a desired result. The *perspective* was from MOOC instructors and other members of the MOOC team as well as learning designers and educational technologists. The *experimental context characterization* is “blocked subject-object study”, according to Wohlin et al. (2012, p. 88), since it involves many participants and more than one object of study.

The scope of the experiment can also be represented through the template defined by (BASILI; DIETER ROMBACH, 1988)

> Analyze *the ad hoc and* LDF4MOOCs *approaches*
> for the purpose of *evaluation*
> with respect to *effectiveness on MOOC Learning Maps*
> from the point of view of *Instructors, Learning Designers, and Educational Technologists.*
> in the context of *Teachers, students and other subjects of the community interested on MOOCs*.

Furthermore, considering that the group of participants were subjected to a treatment, being observed before and after this treatment (i.e., before and after using LDF4MOOCs), this study design also corresponds to a pre-experiment based on an one-group pretest–posttest design (WOHLIN et al., 2012, p. 114). In this case, the treatment was the use of the LDF4MOOCs to develop a MOOC Learning Map.

6.1.2 Hypotheses and Variables

The experimental study definition was formalized into null and alternative hypotheses. The null hypothesis is that one we want to reject, and the alternative hypothesis is the one we expect to assume as true.

The measurement used in the studies (i.e., effectiveness) is subjective. According to Wohlin et al. (2012, p. 40), a subjective measure depends on both the object and the viewpoint from which they are taken. In addition, they are always subject to potential bias. It is also an indirect measure once it involves the measurement of other attributes. In this case, it involves all the dimensions and items considered by the used metric (i.e., the *Instrument to Support the Evaluation of Learning Maps in the MOOC Context*, Appendix C). Table 28 summarizes the main features of the experimental study.

Table 28 - Main characteristics of the experimental study.

Feature	Short description		
Null and alternative hypothesis	H_0: MOOC Learning Maps developed by using the LDF4MOOCs framework have the same average score for effectiveness as those developed by using an ad hoc basis, with respect to the adherence of the maps to the desirable characteristics for MOOCs specified in the rubric. H_1: MOOC Learning Maps developed by using LDF4MOOCs have higher average score for effectiveness than those developed by using an ad hoc basis, with respect to the adherence of the maps to the desirable characteristics for MOOCs specified in the rubric.		
Dependent variable	Learning Map quality (score of adherence to the desirable characteristics for MOOCs specified in the rubric).		
Independent variables	Ad hoc versus the proposed LDF4MOOCs.		
Workshops' location	Institution A Alfenas-MG	Institution B Muzambinho-MG	Institution C Machado-MG
Date	September, 2016	November, 2016	May, 2017
Number of Participants	5	12	26
Learning Maps considered since some subjects worked in pairs.	3	5	12
Total of objects of study (i.e., MOOC Learning Maps) for each approach (ad hoc and LDF4MOOCs)	20 (i.e., 3 + 5 + 12)		

Source: Elaborated by the author.

6.1.3 Participants

There were 43 participants in all the study, randomly selected on a voluntary basis, and without getting any compensation. They had no previous experience on the development of MOOCs, which we consider important to maintain the homogeneity of the collected data and decrease the influence of the subjects' backgrounds in the results.

Around 58% of the participants were male, and 42% were female. 7% were teachers with background in Computer Science, and 93% were undergraduate students in the same area or correlated fields (e.g. mathematics, engineering). 90% of the participants were in the 17–24 age range, 7% were in the 25–34 age range, and 3% were in 35-44 age range.

6.1.4 Materials and Instruments

All workshops were performed in single informatics laboratories with access to desktops and internet. The participants had the option to work in pairs or individually, as we said previously. Firstly, we used an online questionnaire[68] to characterize the participant's profile.

General instructions were given, so they began using an online editor to develop their first MOOC Learning Map on ad hoc basis. LDF4MOOCs, in turn, was available at http://caed.icmc.usp.br/mooc.

Two specific online questionnaires were created to support the participants (or group of participants, considering those who worked in pairs) in the step of self-measuring the effects of the use of the ad hoc method to create a MOOC Learning Map as well as to verify another map created using the LDF4MOOCs framework. They are available at http://bit.ly/2hulBQq (i.e., questionnaire to evaluate the MOOC Learning Map created on an ad hoc basis) and http://bit.ly/2z7Xt18 (i.e., questionnaire to evaluate the map created by using the LDF4MOOCs). Both questionnaires used the same rubric, which is an adapted version of the *Instrument to Support the Evaluation of Learning Maps in the MOOC Context* (Appendix C); also described in Section 5.4. Such rubric had eight dimensions of desirable characteristics for MOOCs. Each dimension containing several items, considering a total of 35 items in all the instrument. The participants had to check twice to what extent their Learning Maps contemplated such items.

A specific questionnaire was also designed to investigate the level of satisfaction, confidence, ease of use, and future intention of the subjects in relation to LDF4MOOCs use to design MOOCs. The last questionnaire[69] was used to collect the participants' impressions about the workshop.

6.1.5 Data Collection and Analysis

The main focus of the experimental study was to verify the data collected from the questionnaires used by the participants to self-evaluate their maps. Since the rubric was based on a four-point Likert scale (not contemplated; partially contemplated; sufficiently contemplated; totally contemplated), we firstly had access to qualitative ordinal data. The data were transformed considering this rule: not contemplated→0; partially contemplated→1; sufficiently contemplated→2; totally contemplated→3). Then, we calculated the corresponding

[68] http://bit.ly/2mxHIL5
[69] http://bit.ly/2zNUhVC

averages of answers given by each participant (or group, for those working in pairs), concerning the items of each dimension, and the dimensions themselves.

After the data was collected, a statistical analysis was conducted to measure any significant differences for Learning Map quality (score of adherence to the desirable characteristics for MOOCs specified in the rubric) between the MOOC Learning Maps developed on an ad hoc basis and those built by using the LDF4MOOCs framework. Due to the non-parametric conditions of the study (i.e., quantitative and paired data; the sample itself acts as a control group; the observation pairs are mutually independent; ordinal measurement scale), a distribution-free signed rank test (Wilcoxon) was used for the statistical analysis by following the ideas presented in (HOLLANDER; WOLFE; CHICKEN, 2014, chap. 3). The analysis was performed using the computing environment R (version 3.4.3).

The null hypothesis (H_0), as presented in Table 28, is that MOOC Learning Maps developed by using the PL have the same average score for adherence to the desirable characteristics for MOOCs as those developed by using an ad hoc basis, i.e., H_0:θ= 0. Otherwise, the alternative hypothesis (H_1) is that it is not, i.e., H_1>0. In addition, a p-value is used to identify the significance of the results, and a small p-value (smaller than 5%, by default) indicates strong evidence against the null hypothesis (H_0).

Thus, considering all dimensions together, we found that the general p-value is smaller than the significance (level of confidence at 5% by default) and the null hypothesis: there is no difference between the results when using an ad hoc basis and using the PL as strategies to design MOOC Learning Maps - must be rejected.

Analyzing each dimension separately, p-value is also smaller than the significance (5%) for all of them, as Table 29 presents. Again, H_0 must be rejected, indicating that, under the circumstances previously described, MOOC Learning Maps developed by using LDF4MOOCs have higher average score for effectiveness than those developed by using an ad hoc basis, with respect to the adherence of the maps to the desirable characteristics for MOOCs specified in the rubric used by the participants.

Table 29 - Tests for dimensions.

Dimensions	p-value
(1) Competency-based design	0.2004%
(2) User-centered learning	1.284%
(3) Self-Regulation learning	1.331%
(4) Social Networking and Collaborative Learning	<0.0001%
(5) Deep Learning, knowledge creation and sharing	4.45%
(6) Assessment and Understanding	<0.0001%
(7) Accommodate differences	2.695%
(8) Feedback	0.05501%

Source: Elaborated by the author; the dimensions are in accordance with Section 5.4.

Table 30 shows the results of applying the Wilcoxon Signal Test separately for each item (i.e., each question in the related rubric, by dimension). H_0 was accepted (p-value > 5%) in 21 of the 35 items (60%) and rejected in the remaining 14 (40%). In this case, as the sample size is larger (i.e., a questionnaire with sample size of 700, being 35 items x 20 groups/participants), it was easier to perceive whether or not there was a significant difference in a lower level. When we have smaller samples, more evidence of difference between means are needed. This individual analyzes helped us to identify the items in which H_0 was not rejected. With this information, we were able to identify other educational design patterns, and also improve the current ones, in order to cover the items, i.e., the desirable characteristics for MOOCs in a more effective way.

Table 30 - Tests for individual items.

Dimension	Item	p-value
(1) Competency-based design	1	1.824%
	2	*22.97%*
	3	*17.99%*
	4	*5.251%*
	5	*17.3%*
(2) User-centered learning	6	*20.97%*
	7	*11.13%*
	8	*26.36%*
	9	*55.03%*
	10	0.2283%
(3) Self-Regulation learning	11	*6.702%*
	12	3.797%

	13	*8.67%*
	14	*59.6%*
(4) Social Networking and Collaborative Learning	15	0.3504%
	16	0.05597%
	17	0.3416%
	18	0.1943%
(5) Deep Learning, knowledge creation and sharing	19	*34.18%*
	20	*6.199%*
	21	*13.42%*
(6) Assessment and Understanding	22	0.1248%
	23	0.04348%
	24	1.392%
	25	2.0%
	26	2.491%
	27	*60.35%*
	28	*8.418%*
(7) Accommodate differences	29	*19.76%*
	30	*75.42%*
	31	1.509%
	32	*6.957%*
(8) Feedback	33	0.1461%
	34	*8.059%*
	35	*9.26%*

Source: Elaborated by the author; dimensions and items are in accordance with Appendix C.

To conclude, according to Koper and Tattersall (2005), using learning design rules will probably result in better courses than ad hoc and random decisions about a course design. Furthermore, in Chapter 3 we also identified that MOOC practitioners using some ad hoc or random decisions tend to replicate to the massive, open and online context the traditionally practices adopted in face-to-face courses or even in formal virtual teaching (i.e., courses recognized by educational authorities). Thus, this experimental study provided some preliminary evidences about the positive influence of using the proposed LDF4MOOCs framework to support the design for learning in MOOCs.

6.1.6 Study's Validity

Despite the positive results previously discussed, as well as our efforts to avoid bias and threats to validity, some factors may also have limited its value for the population of interest (i.e., instructors, learning designers, MOOC researchers, technologists). Such factors are mainly focused on the experiment design (construct validity) and the difficulties to generalize the findings (external validity).

To minimize the threats to the construct validity, we focused on the composition and homogeneity of the participants: all participants were novice in the MOOC development context, conducting such type of activity for the first time, and attending the experimental study only once. Furthermore, we conducted the study in real settings (i.e., as training course in an academic context). It was not presented to the participants as an experiment, which may have reduced concerns related to their behavior. Another point to consider is the fact that the questionnaires used to evaluate the maps had the same format. However, the participants had to create two different MOOC Learning Maps, considering two distinct topics of their own choice, which may have reduced their receptiveness and sensibility to avoid or reduce errors. Also, there were social treats to construct validity: the number of participants was relatively small (43 participants, but since some of them worked in pairs, the number of objects of study considered was 20 for each approach, i.e., ad hoc and the LDF4MOOCs framework). The small number of participants is also related to the subjects' background since the interest of Computer Science participants by education and learning design is not widely settled yet.

To reduce threats to external validity, we conducted the study in realistic setting conditions (i.e., as training course in an academic context) and using three different geographical locations. In addition, despite being conducted as workshops in academic weeks of Computer Science courses, the participants were free to design MOOCs on diverse topics. In fact, diverse contexts were considered: music, programming language, health food, self-makeup, dance, introduction to human-computer interaction, and web development. To conclude, we are aware that the participants homogeneity regarding their knowledge on MOOC development (i.e., novice MOOC practitioners) may affect external validity, but it can also be explained by the recent history of MOOCs. However, the growing interest in the development of MOOCs may facilitate the interaction with experienced practitioners in the coming years.

6.2 CASE STUDIES

Case studies are conducted to investigate a single entity or phenomenon in its real-life context, within a specific time space. They come from different sources of evidence, such as documentation, archival records, interviews, direct observation, participant-observation, and physical artifacts, among others (WOHLIN et al., 2012, pp. 14).

The Participant-Observation approach, for instance, is a special kind of observation in which the researcher is not merely a passive observer. The researcher assumes a variety of roles within a case study situation and may actively participate in the events being studied (YIN, 2011). In the MOOC context, Participant-Observation was used by (NKUYUBWATSI, 2014, pp. 4) to see cultural translation from the MOOC students' point of view rather than from the perspective of an external commentator. The researcher selected courses in which he was interested, as a student, and tried to simulate how students engage with courses, from the course selection to the course completion level.

In our work, in order to understand how MOOCs can be developed, a set of case studies based on the Participant-Observation approach were performed from 2015 up to 2017. The case studies consisted in planning, developing, and delivering MOOCs using current versions of the Learning Design Framework for MOOCs (LDF4MOOCs), i.e., the current version in the period of the MOOC planning. In fact, such case studies were used as formative evaluation of the LDF4MOOCs framework and its elements during the development and improvement phases.

Table 31 summarizes the data related to all the case studies performed during our work.

Table 31 - Summary of MOOCs developed during the Ph.D. research.

-	Meta-MOOC I	CS1	CS2	CS3	Meta-MOOC II
Case Study	*Exploring the MOOCs*	*Agile Software Development*	*Web Development with Bootstrap, CodeIgniter, and Agile Practices*	*Introduction to Software Testing*	*Creating Learning Projects for MOOCs*
Original name	*Explorando os MOOCs*	*Desenvolvimento Ágil de Software*	*Desenvolvimento Web com Bootstrap, CodeIgniter e Práticas Ágeis*	*Introdução ao Teste de Software*	*Projeto de Aprendizagem para MOOCs*
Short description and main pedagogical strategy	An introductory meta-MOOC (i.e., a MOOC to talk about MOOCs), supported by Case-based learning.	Agile software development using Project and Problem-based Learning, and a learning community on Facebook.	A practice-driven introductory course that used the Project-Based Learning approach as the main strategy to support the development of web development skills and agile practices.	A specific introductory course in the Software Engineering field having Case-Based Learning as the main pedagogical strategy.	An experimental open course. The students had to use LDF4MOOCs to develop a MOOC Learning Map. Project-based learning was the main pedagogical strategy used.

Offering:	May 2016 to June 2016	November 2016 to December 2016	November 2017 up to December 2017	February 2018; with automatic offers every 4 weeks	July 2017 to September 2017
Number of weeks	6	7	6	6	6
Provider	Tim Tec IFSULDEMINAS	Tim Tec IFSULDEMINAS	MiríadaX IFSULDEMINAS	Coursera USP	Tim Tec IFSULDEMINAS
Partners	London Knowledge Lab, Birkbeck College. Multimedia department.	Ateliê de Software da empresa Webgoal (Poços de Caldas, MG); Invited talkers from the industry.	IFSULDEMINAS Multimedia department; One web developer from InvictaWeb, Muzambinho – MG); Invited talkers from the industry.	Two teachers and two Ph.D. Candidates from ICMC/USP; Management Project (USP-Coursera); ICMC/USP Multimedia department; Invited talkers from the industry and academy.	IFSULDEMINAS Virtual and Open Education Department.
Registered users	199	647	665	3009	160

Source: Elaborated by the author.

The case studies are detailed in the next sections. Their organization follows the main phases of the MOOC Life Cycle Process (exploration, planning, development, delivery, and evaluation/improvement).

6.2.1 Meta-MOOC 1: *Exploring the MOOCs*

Exploring the MOOCs (CS1) is an introductory course about MOOCs. In fact, it is a meta-MOOC, i.e., a MOOC to instigate discussion on the history and fundamentals of MOOCs.

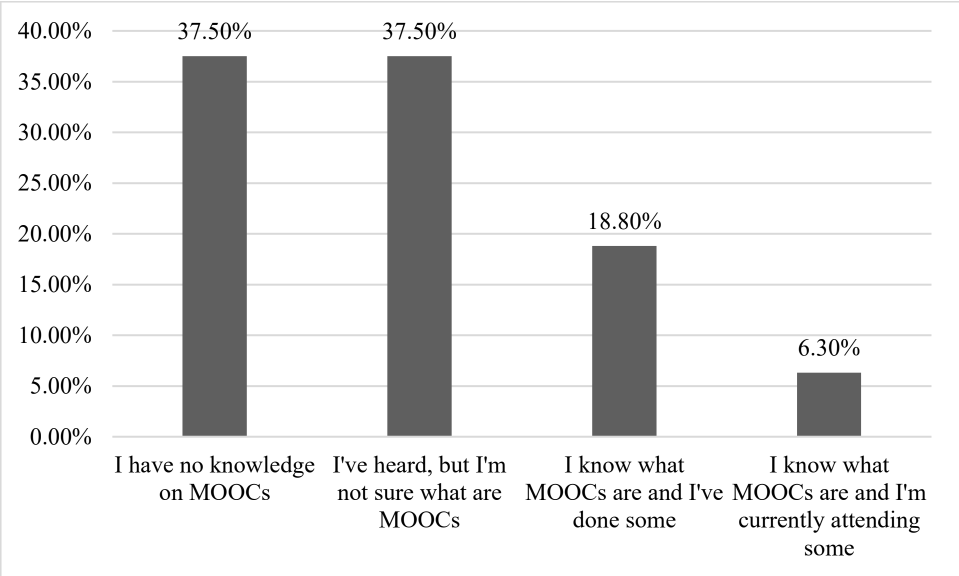
The course was designed considering the preliminary version of the LDF4MOOCs framework in that year (2016), when we were still trying to derive patterns related to the MOOC development context. The main related results were published in (FASSBINDER et al., 2016).

6.2.1.1 *Exploration*

Exploring the MOOCs (CS1) was the first online and open course produced in the IFSULDEMINAS and delivered using the Tim Tec platform. Thus, in 2016, an online questionnaire was distributed in order to understand the current knowledge of the IFSULDEMINAS community about MOOCs, mainly taking into account the administrative and the educational staff (teachers) viewpoints.

We get data from 112 people, which represent 9.6% of the number of the institute collaborators. According to Figure 30, around 37.5% participants said they did not know what a MOOC stands for, while 37.5% said they have heard about MOOCs but were not aware what they really are.

Figure 30 - Knowledge of the IFSULDEMINAS's community on MOOCs, in 2016.



Source: (FASSBINDER et al., 2016).

Beyond the institutional context, it is known that introductory courses, in general, provide an overview of a particular subject domain. In order to understand how introductory MOOCs have been developed, we performed an initial exploratory study across introductory courses from Coursera and Tim Tec platforms, analyzing their learning designs and considering the main ideas defined in (TOETENEL; RIENTIES, 2016). Firstly, the following research question was defined: *What activity types are used in the context of open and online introductory courses?* The learning design activities considered were described in (RIENTIES; TOETENEL, 2016) and summarized in Table 32.

Table 32 - Learning design activities.

Type	Description	Example
Assimilative	Attending to information	Read, Watch, Listen, Think about, Access.
Finding and handling information	Searching for and processing information	List, Analyze, Collate, Plot, Find, Discover, Access, Use, Gather.
Communication	Discussing module related content with at	Communicate, Debate, Discuss, Argue, Share,

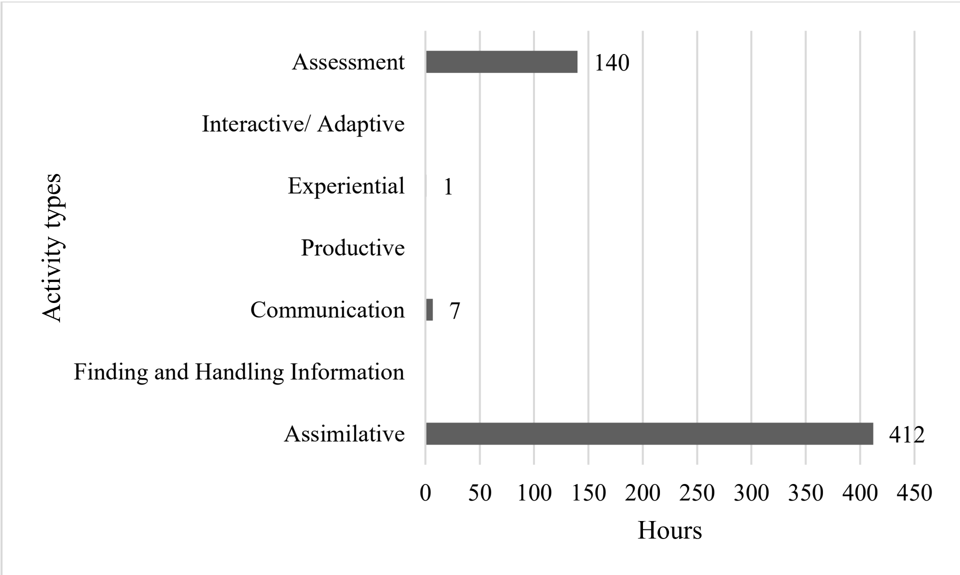
	least one other person (student or tutor)	Report, Collaborate, Present, Describe.
Productive	Actively constructing an artifact	Create, Build, Make, Design, Construct, Contribute, Complete.
Experiential	Applying learning in a real-world setting	Practice, Apply, Mimic, Experience, Explore, Investigate.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

Source: (RIENTIES; TOETENEL, 2016). Adapted from (FASSBINDER et al., 2016).

Secondly, we analyzed learning designs considering the parameters: type of activities and the number of hours that students are expected to study in each activity. The last parameter, particularly, is difficult to measure as students can start their learning journeys at various different points and, as a consequence, the amount of time that they need to meet the assessed learning outcomes is diverse, as highlighted by (THORPE, 2013; TOETENEL; RIENTIES, 2016).

From the 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 quizzes to test the student's ability to answer the questions considering the content explained in videos. Figure 31 highlights educators' 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 31 - Average of Learning design activities per hour in traditional online introductory courses in Coursera and Tim Tec.



Source: (FASSBINDER et al., 2016).

Thus, considering all the presented context and the lack of introductory courses about MOOCs in the Tim Tec database and even in other MOOC providers, we decided to plan and deliver an introductory course about MOOCs.

The next step was to use a mind map to resume and organize the main needs, curiosities, suggestions as well as the characteristics and content appointed by the target audience and collected from a virtual questionnaire. Specific content ideas to be addressed by the introductory course were divided according to the main personas identified through the questionnaire: administrative staff (how to use MOOCs to advance in my institutional career), students (how 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 some 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. We also did an online focus group to discuss this MOOC syllabus. The group was formed by one instructor, one teacher from the educational area, and 10 volunteer members from the target audience who answered the online questionnaire delivered to the IFSULDEMINAS' staff, as described in Fassbinder et al. (2016, pp.9).

6.2.1.2 *Planning*

As we said before, the MOOC was delivered using Tim Tec MOOC platform. In such platform, classes are the central components of the courses and they are responsible for the content organization. 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.

Considering the main syllabus and Tim Tec available resources, we used LDF4MOOCs to develop the learning map related to the course. We specifically used ideas from Flipped Learning and Case-based Teaching method.

The main topics of the map, learning outcomes (goals), activities as well as the main patterns considered are described in Table 33. Objectives were defined by considering Bloom's Taxonomy (KRATHWOHL, 2002).

Table 33 - Exploring the MOOCs: Learning Map

Topic	Goals	Main Activities	Main patterns considered
Before starting the course	Remember (define, list)	Quiz, presentation video showing how the course works, and questions to instigate user's reflection about some issues before accessing the course moment.	DESIGNING ASSESSMENTS QUIZ 2-3 MINUTE VIDEO
Welcome class	Remember (define, list)	Welcome video; Pre-Survey; Presentation forum; Additional readings.	WELCOMING VIDEO SELF-EVALUATION MOOC COMMUNITY FORUM
History of MOOCs	Understand (describe, identify)	Presentation video (resume of the class); Reading about the Open education movement; Case-based video: connectivist MOOCs; Discussion forum; Further discussion.	2-3 MINUTE VIDEO FLIPPED LEARNING-DRIVEN PEDAGOGICAL DESIGN CASE-BASED LEARNING MOOC COMMUNITY FORUM DEEP LEARNING
Types of MOOCs	Apply (use) and Analyze	Presentation video (resume of the class);	2-3 MINUTE VIDEO

	(differentiate and critique)	Case-based video: examples on MOOC providers (NovoEd, Udacity, Coursera); Practical activity; Discussion Forum.	CASE-BASED LEARNING DEEP LEARNING STUDENT MINERS BE FLEXIBLE MULTIPLE RIGHT WAYS
Platforms, Providers and Courses	Analyze (differentiate and compare) Evaluate (select, judge)	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, FutureLearn); Practical activity; Quiz.	2-3 MINUTE VIDEO CASE-BASED LEARNING DEEP LEARNING STUDENT MINERS BE FLEXIBLE MULTIPLE RIGHT WAYS
Real Experiences (Applications)	Create (Design, 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).	2-3 MINUTE VIDEO CASE-BASED LEARNING DEEP LEARNING STUDENT MINERS MOOC COMMUNITY FORUM BE FLEXIBLE MULTIPLE RIGHT WAYS

Source: Elaborated by the author. Adapted from (FASSBINDER et al., 2016, p. 9).

6.2.1.3 *Development*

In the development phase, specific videos for the course were recorded and edited using the Birkbeck College – University of London media service support, during the internship conducted from 2015 to 2016, in the Knowledge Lab, London, which was financed by CNPq (Science Without Borders Program).

The videos were developed considering best practices to produce multimedia online videos for MOOCs (2-3 MINUTE VIDEO). 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 based on common Open Educational Resources (OERs) guidelines (OER-MADE MOOC). Finally, the Learning Map (Table 33) was implemented in Tim Tec platform, according to the DEVELOPMENT and DELIVERY PATTERNS categories.

6.2.1.4 *Delivery*

The course was first launched in May 2016 and stayed online for six weeks. A second launch occurred between August 2016 and September 2016. A total of 199 users registered for the course, including students from IFSULDEMINAS face-to-face courses, teachers, administrative staff, and community as a whole.

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.

6.2.1.5 *Evaluation and Improvement*

A summary of the main collected data is presented next:

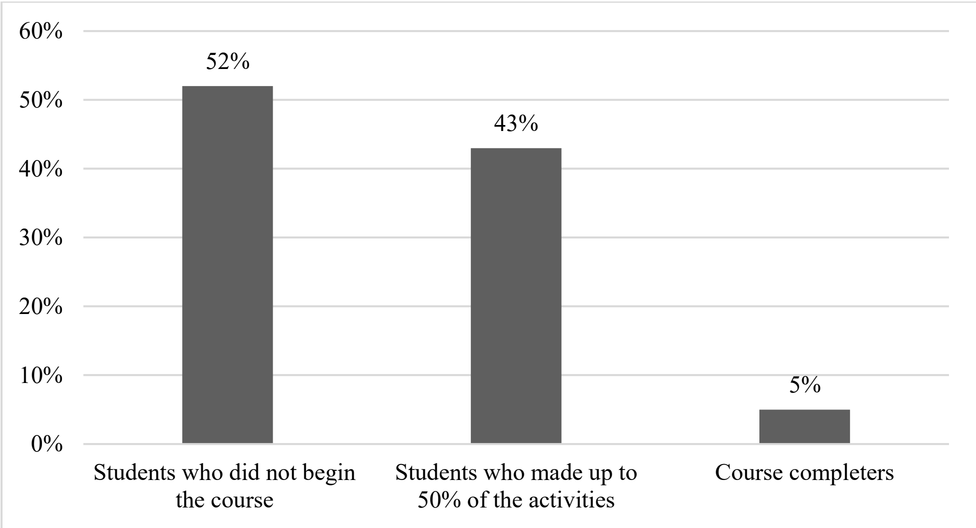
- Brazilian state of origin: Minas Gerais (68.8%), Piauí (6.3%), Santa Catarina (6.3%), São Paulo (6.3%), Bahia (12.5%).
- Genre: 75% male and 25% female.
- Occupation: Teachers (37.1%), Administrative staff (12.5%), Postgraduate students (6.3%), undergraduate students (18.8%), High-school students (6.3%),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

We initially explored students' perceptions about the course since it is difficult to evaluate MOOC quality and dropout rate in the same way as a formal course with traditional degree awarding process (CONOLE, 2014a).

Moreover, it is important to highlight limitations concerned with the context in which the case study was performed, since the Tim Tec platform is a Brazilian initiative still under development, and the course was the first attempt performed by instructors from IFSULDEMINAS in the context of open and online courses.

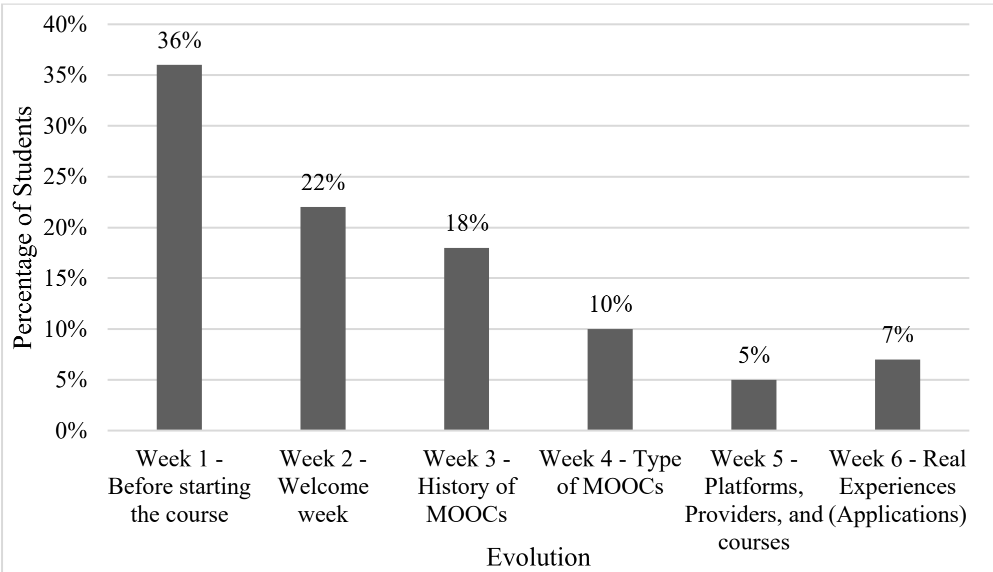
Figure 32 presents the percentage of completion of the course, while Figure 33 describes the average progress of students per week.

Figure 32 - Distribution of students and their situation in the course.



Source: (FASSBINDER et al., 2016).

Figure 33 - Average progress of students per week.



Source: (FASSBINDER et al., 2016).

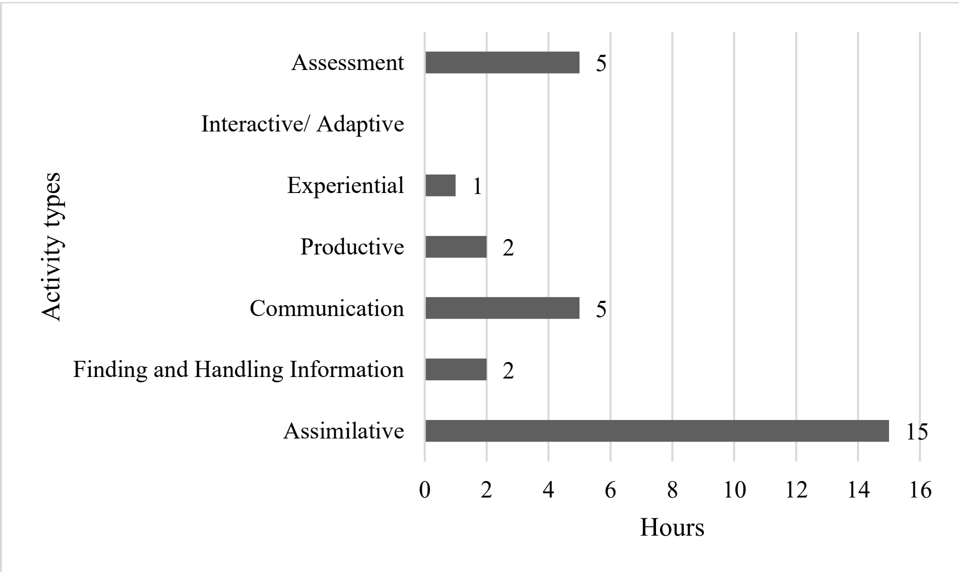
In a post-survey, MOOC users who failed to complete the course were asked to indicate the reasons for their MOOC withdrawal decision, or to explain what hindered them from becoming fully engaged. Poor time management was the main aspect mentioned by students who were not able to complete the course.

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. 17 new topics were created by students. However, participation number of responses was still low.

An initial analysis of the average of learning design activities per hour in the courses based on LDF4MOOCs (Figure 34) demonstrates a diverse use of activities when compared to the scenario presented in Figure 31. The number of hours that students need to perform each activity is also smaller using our approach.

Figure 34 - Average of learning design activities per hour in an introductory MOOC developed under the guidance of LDF4MOOCs proposed in this thesis.



Source: (FASSBINDER et al., 2016).

According to Nulden (1999), introductory courses are often designed according to a sequential model, with lectures, self-study and practice as the main building blocks. The aim of introductory courses is generally to give students a "big picture" or overview of a field. Nulden (1999) 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 addition to use this case study to initially evaluate and refine the LDF4MOOCs framework, we also experimented an alternative view on designing introductory MOOCs.

6.2.2 Case Study 1: *Agile Software Development*

This subsection is grounded on (FASSBINDER et al., 2017) and describe the design of the *Agile Software Development MOOC (CS1),* which was supported by the proposed

LDF4MOOCs. The text is organized along the main phases defined in the MOOC Life Cycle Process (exploration, planning, development, delivery and evaluation/improvement).

6.2.2.1 *Exploration*

A face-to-face and fee-paying training course that inspired our *Agile Software Development MOOC* had some limitations. Due to space limitation, only 12 people could attend the course each time it was delivered. The course also required specific prerequisites of technical nature, such as experience in Ruby on Rails (i.e., web-application framework), Git (i.e., version control system), and Docker (i.e., software container platform). We wanted to design a MOOC open to everyone with experience in at least one programming language (e.g. Java, C, Python). In addition, activities and learning materials should be adapted to include people with different levels of backgrounds and interests in Agile Software Development. Therefore, making innovative changes from a face-to-face context to a MOOC posed several challenges to be investigated.

Firstly, the patterns Know your Learners and Personas and Stories Collection were used to collect user stories from the target public. A mind map was used to resume and organize the main needs, curiosities, suggestions, characteristics, and content appointed by the target audience.

We applied the pattern Browse existing MOOCs for inspiration to verify the current design of related MOOCs. The main situation is formalized in (FASSBINDER et al., 2017), as previously described. In resume, software engineering MOOCs are traditionally taught deductively. There are videos where the instructor introduces a topic by lecturing on general principles; then forums and quizzes are used to test student’s ability to answer questions considering the content explained in videos. The average of hours that students are expected to perform the activities is also high. Moreover, regular assimilative activities include reading texts and watching videos, and frequent assessment activities involve multiple question choice.

Considering the patterns Suitable MOOC Platform Selection and Adjacent Platforms, the *Agile Software Development MOOC* was created and delivered using the Tim Tec platform[70]. The course was complemented by a Facebook group as a collaborative learning space. Portuguese was the main language to develop videos, texts, and other educational resources.

[70] mooc.ifsuldeminas.edu.br

6.2.2.2 *Planning*

Considering the main syllabus and Tim Tec available resources, we used the PLANNING PATTERNS category of the Educational Design Pattern Language to develop the learning map related to the *Agile Software Development MOOC*. PROJECT-BASED LEARNING was used as the main active learning strategy to guide activities in the platform. PROBLEM-BASED LEARNING was used to guide discussions in the MOOC's Facebook group. The map's main topics and activities are summarized in Table 34.

Table 34 – Agile Software Development: Learning Map overview.

MOOC: Agile Software Development Platform: mooc.ifsuldeminas.edu.br (Tim Tec)		
Learning goals	MOOC Platform	Facebook group
Before starting the MOOC		
Remember Understand Create	How the course works; Personal presentation through recording and sharing video interview; Initial question about challenges when developing systems; Self-evaluation.	Sharing the video interview. Sharing opinion about challenges when developing systems;
Welcome Class		
Remember Understand Create	Welcome video by instructors; Survey and characterization of students; Guidelines for Glossary-Based Collaboration; Readings.	Using #PairWithMe to find a partner.
Traditional Approach to Software Development		
Remember Analyze Create Evaluate	Project 1: Seven days to develop some functionalities, using student's current knowledge.	Sharing problems and new issues that hamper software development.
Manifesto for Agile Software Development		
Understand Analyze	Video interviews with software engineers about their contact with the Agile Manifest, and its values and principles.	Problem-solving using values and principles defined in the Agile Manifesto.
Iterative and incremental development		
Understand Analyze Apply Create Evaluate	Project 2: 7 days to 3 fast deliveries (3 days, 2 days, 2 days).	Sharing problems and new issues that still hamper software development. Making comparisons between traditional and agile development approach.
Agile practices: A big list		

Understand Analyze Apply Create Evaluate	Hands-on, interview videos, and practical pair activities about Kanban, Scrum, XP, Pair Programming, Virtual Pair Programming, Test-driven development.	Sharing experiences when programming in pairs.
Consolidation of Experiences		
Remember Analyze Evaluate	Webinar; Final self-evaluation; Last updated in Learning Mosaic.	Questions for a webinar with Software Engineers that use Agile strategies;

Source: Elaborated by the author.

6.2.2.3 *Development*

In this phase, specific videos were recorded and edited using the IFSULDEMINAS Campus Muzambinho media service. Videos were designed considering patterns of best practices when producing multimedia online videos for MOOCs, defined in the Educational Design Pattern Language for MOOCs (2-3 MINUTE VIDEO). 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 Open Educational Resources (OERs) pattern (OER-MADE MOOC). Finally, the Learning Map (Table 34) was implemented in Tim Tec.

6.2.2.4 *Delivery*

The course was launched in November 2016 and stayed online for seven weeks. The first week was called "Before starting the MOOC". It was reserved to introduce some initial questions to motivate registered users to reflect on concepts to be worked during the course, and to regulate their learning process. We used the DELIVERY PATTERNS category of the Educational Design Pattern Language to support this phase. In addition, three students were invited to act as voluntary tutors.

6.2.2.5 *Evaluation and Improvement*

Data to verify the MOOC's effectiveness were collected from questionnaires, reports from the MOOC platform, and a semi-structured interview with a sample of 20 students for deeper clarification of some points.

About 650 students enrolled in this MOOC. Considering the IFSULDEMINAS preliminary investment on this type of learning modality, such demand was high. The average number of enrolments per course on the institution' MOOCs was around 50 users. From a students survey, we identified that at least three reasons contributed to the higher enrolment rate: (i) greater interaction with market professionals; (ii) use of active learning strategies (project and problem-based learning); and (iii) increasing demand for professionals with knowledge in agile practices.

The geographic reach of the course was also significant. Students from 20 different Brazilian states registered on the course. It is worth noticing the diversified distribution of students by degree summarized in Table 35.

Table 35 - Learning design activities.

Current highest degree	% of Students
High school in progress	2.56
High school	4.27
Bachelor’s degree in progress	44.44
Bachelor’s degree	21.37
Specialization in progress	0.85
Specialization	9.40
Master’s degree in progress	2.56
Master’s degree	7.69
Ph.D. in progress	4.27
Ph.D.	2.56

Source: (FASSBINDER et al., 2017).

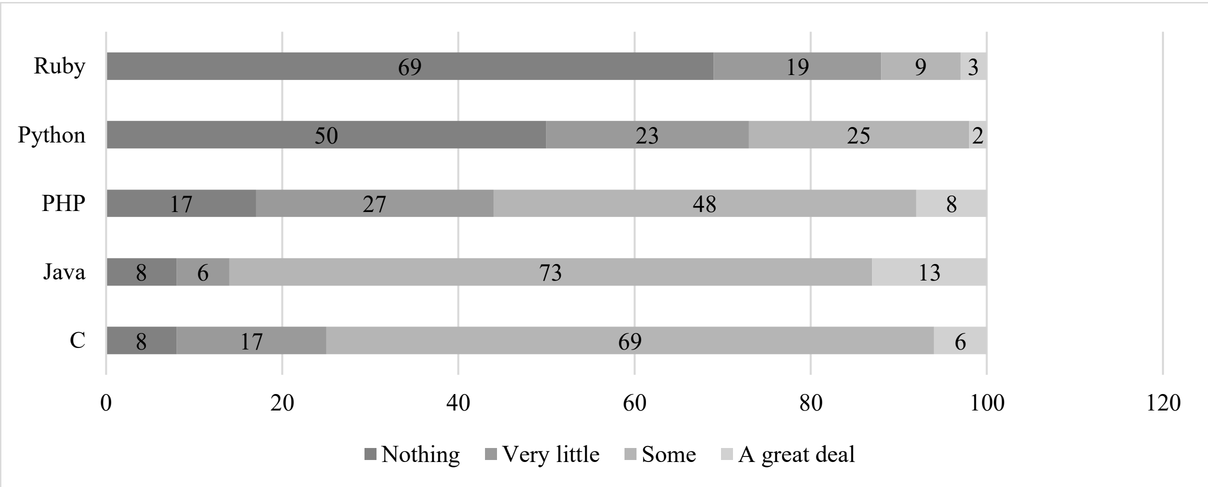
Around 12.7% of those enrolled finished the MOOC, having completed more than 70% of the proposed activities. Still being a small value, we need to highlight that the current average completion rate for IFSULDEMINAS MOOCs was around 5%. Besides, according to Onah, Sinclair and Boyatt (2014), defining ‘dropout’ in MOOCs is a difficult task because this term is traditionally used in face-to-face and formal educational contexts. In MOOCs, participants can join a course just to follow a particular topic or to explore it. Once their goals are achieved, they voluntarily withdraw.

Taking into account interventions made in the MOOC Learning Map, around 62.5% of students who completed the MOOC stated that deadlines suggested by instructors were not considered. This situation indicates that although suggesting dates and deadlines to complete activities is a strategy to support self-regulated learning, the dates should be flexible for those who want to follow their own learning path and pace of study.

Close to 59.4% of participants attended activities in all environments, both MOOC platform and Facebook group; 37.5% used only the MOOC platform; and 3.1% only the Facebook group. Although several other digital tools can be used to complement learning, such as blogs and social networks, this suggests that MOOC platforms remain the primary environment. In this case, the Facebook group seemed to have less influence on student's motivation to conclude the course.

When asked about their knowledge level in programming languages, most participants said they had some knowledge in C and Java, and no knowledge of Python and Ruby at all. The knowledge distribution seems uniform when verifying student's skills to develop complete programs with PHP, CSS, JavaScript, and databases (Figure 35). This indicates that the lack of advanced or intermediate knowledge in programming languages contributed to the dropout rate, in this case. It is important to highlight that the minimum requirement to subscribe the MOOC was basic programming knowledge in at least one programming language.

Figure 35 - Programming language knowledge distribution (in %).



Source: (FASSBINDER et al., 2017).

When asked about the main differences between the *Agile Software Development MOOC* and other online courses that the related students had already completed, the main areas identified were: (i) interaction between theory and practice; (ii) the methodology used (project and problem-based learning); (iii) the MOOC put the focus on students and not on instructors; (iv) schedule flexibility; and (v) more opportunities for interaction and collaboration between peers. Thus, this suggests that the interventions in the MOOC pedagogical approach were perceived and they were well-received by students.

Students were also asked about primary main intention when enrolling in the course: "I want to do all the activities to complete the course and reach a certificate" (71.9%), "I want to explore the course, see how it works, but I'm not sure if I'll complete it" (28.1%).

At the end of the course, we also asked if their initial intentions were fulfilled. About 32% said "yes", they did everything they had planned to do in the course. The others indicated problems that hindered them from achieving prior goals, such as problems to find someone to work as a pair when this was required by some programming activities, and difficulty in organizing time and creating a study schedule to carry out the MOOC activities successfully.

Almost 40% of the students preferred working independently to working in pairs. Some of them reported that stopped doing the activities in pairs because of the difficulty to find an adequate mate.

We also used the characteristics desirable for MOOC Learning Maps presented in the *Instrument to Support the Evaluation of Learning Maps in the MOOC Context* (Appendix C and Section 5.4) to identify students' opinions about learning strategies used to develop the MOOC. Specific subquestions (indicators) were used to collect data about each particular characteristic, as exemplified in Table 36.

Table 36 - Example of subquestions related to the Instrument to Support the Evaluation of Learning Maps in the MOOC Context (Appendix C).

Dimension: Competency-based Design
Question 1: I liked the course used problems and projects as a teaching-learning strategy.
Question 2: I liked the course contemplated a learning process more oriented to the accomplishment of activities than to the exposition and theoretical explanation of content (lectures).

Source: Adapted from (FASSBINDER et al., 2017).

The five-point Likert scale was used to establish the level of students' agreement, ranging from *I totally agree (5)* up to *Totally disagree (1)*. In general, students' considerations about the MOOC learning design were positive. Two extremes were selected and analyzed: one very positive and another implying some indifference.

Prevalence of *Totally Agree*

- I liked the course used short videos (1 to 5 minutes) to guide students in activities that should be developed (Competency-based design).
- I enjoyed taking the course at my own pace (User-Centered Learning).
- I felt motivated to continue learning and discussing agile practices even after the course is over (Deep-Learning, creation, and sharing of knowledge).
- I liked the course used a variety of media to capture and retain my attention (Accommodate differences).
- Messages sent by instructors were helpful (Feedback).
- I liked the interview videos with software engineers (Competency-Based Design).

Uniform distribution, with the prevalence of *Neither agree nor disagree*

- Time reserved for pre-start activities was relevant to my learning process (Self-Regulation Learning).
- I liked the strategy of recording a video interview for presentation (Social Networking and Collaborative Learning).

From these answers, we can notice some relevant points: (i) the importance of a closer relationship between academic and market professionals; and (ii) the use of strategies to support mainly communication, self-expression, metacognition, and self-regulation skills.

As presented in the Learning Map (Table 34), students were asked to find relevant terms related to Agile Software Development and put them in a glossary. This web activity was also used to promote collaborative writing and to emphasize the understanding of appropriate terminology. A total of 37 glossary terms was produced. The collaborative construction of glossaries in massive open online courses is not so common as it is in traditional educational implementations due to technological limitations of MOOC providers to support massive student contributions and a deeper learning analysis.

Finally, it is important to highlight that, despite the maturation and development of the software engineering area and the agile movement, the use of agile methods in software engineering face-to-face or virtual courses is still a relatively new phenomenon (RICO; SAYANI, 2009). According to De O. Melo et al. (2013), adjustments in curricula on software engineering education to conform to this new paradigm of software development are necessary. However, this is a challenging endeavor that requires alignment between theory, hands-on experiences, real projects, time to develop software, a place for building the agile environment, and the presence of several roles and stakeholders (DE O. MELO et al., 2013). Believing that this issue deserved further investigation, we decided to focus on a MOOC about agile development to support lifelong learning in this context.

6.2.3 Case Study 2: Web Development with Bootstrap, CodeIgniter and Agile Practices

In mid-2017, IFSULDEMINAS signed a partnership with the company that manages the MiríadaX platform. The institute became the first Brazilian Federal Institute of Education, Science and Technology partner of MiríadaX and joined a partnership of other 105 institutions around the word. Since that, the institute's faculty has been boosted to deliver MOOCs using such web environment. Next, we describe the MOOC named *Web Development with Bootstrap, CodeIgniter and Agile Practices*, which is the IFSULDEMINAS's initial course launched on such platform. The main related results were published in (FASSBINDER et al., 2018).

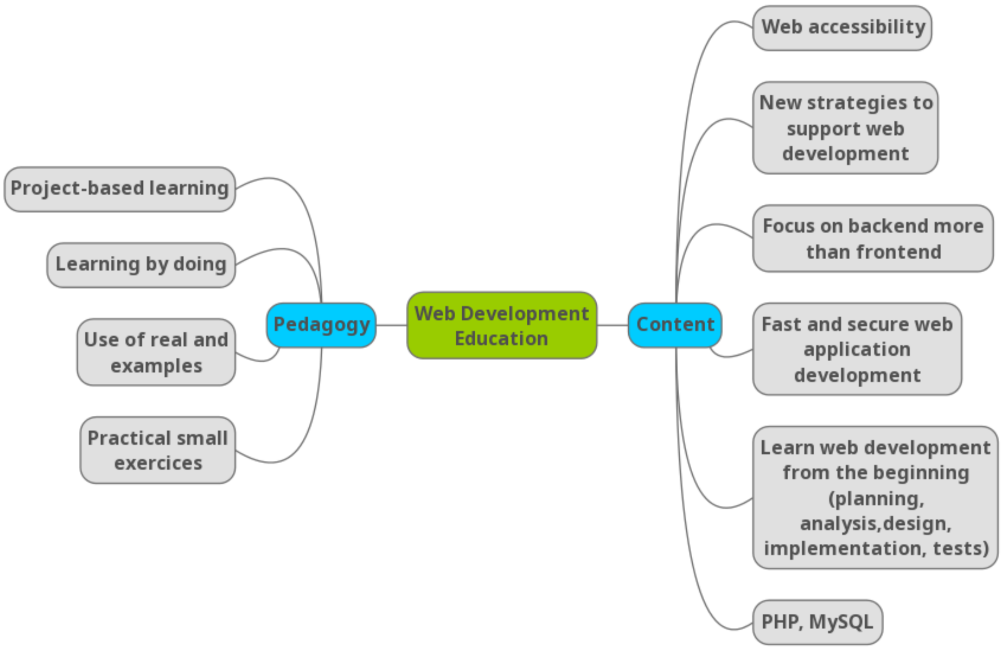
6.2.3.1 *Exploration*

The challenges for teaching web development and accessibility to the masses, through a MOOC, for example, are larger, mainly due the difference in characteristics between leaners (GAY; DJAFAROVA; ZEFI, 2017). In such massive, open and online context, another issue addressed in (FASSBINDER et al., 2017) is the difficult instructors face when designing competency-based activities to support the development of skills required by the industry, such as the use of agile practices to encourage simple, more lightweight, and faster software development (BARROCA; KEAR, 2016). Such practices include pair-programming; sharing, discussing, and giving feedback; iterative and incremental development, among others.

Believing that web development education deserved further investigation, we decided to focus on a MOOC about web development that combines Bootstrap and CodeIgniter together with agile development, in order to support lifelong learning in this context.

Thus, the patterns KNOW YOUR LEARNERS and PERSONAS AND STORIES COLLECTION were used to understand the audience' knowledge on web development and agile practices, and to collect user stories about the skills they would like to develop by attending a MOOC on such context. The next step was to use a mind map (Figure 36) to resume and organize the main needs, curiosities, suggestions as well as characteristics and content appointed by the target audience and collected from a virtual questionnaire.

Figure 36 - Mind map about the audience' needs for a web development MOOC.



Source: Elaborated by the author.

As we previously said, the MOOC was delivered through MiríadaX platform. The courses in the platform consist of compulsory and optional activities. Course content is organized in modules. Each module may contain one or more external resources (e.g., video, figure, text from external servers), pool (e.g., a test to know students' opinion about a topic), P2P (i.e., pair evaluation), and multiple-choice questions (i.e., questions where the student should choose one or more correct answers). The platform also provides a discussion forum, tools to support instructors-students' communication in an automatic way, general reports on the course statistics (e.g., demographic data, students' progress in the course). Data can also be exported to be analyzed by external approaches and tools.

6.2.3.2 *Planning*

Considering the main syllabus and MiríadaX available resources, we used the LDF4MOOCs framework to develop the activities map related to the course. We specifically used ideas from Flipped Learning and Project-based Learning.

The main topics of the map, learning outcomes (objectives), activities as well as the main patterns considered are described in Table 37.

Table 37 - Main features of the Web Development with Bootstrap, CodeIgniter and Agile Practices MOOC.

Objectives	Main Activities	
Topic: Before starting the Course		
Examine related knowledge prior to the course; Identify the course organization; Define your own learning goals.	Welcome video; Introduce yourself using a video or text; Leaners' characterization survey; Pre-test; Self-evaluation; Initial question to active prior knowledge.	BEFORE THE COURSE STARTS WELCOMING VIDEO POOL BE FLEXIBLE SELF-EVALUATION PRE AND POST TEST
Topic: Web Development Fundamentals		
Draw connections between prior knowledge on web development and the content to be approached by the course.	Use of a model system and hands-on activities to explore the concepts related to web development fundamentals; Quizzes.	DEEP-LEARNING QUIZ
Topic: Towards the Practical Project		
Identify the concepts related to the use of agile practices in the web development; Organize a Requirements Analysis document for your practical project by using agile practices; Define a viable minimum version of a software to be implemented during the course.	Lecture on agile practices; Hands-on activities related to the requirements analysis document creation by using agile practices; Pair-evaluation of the document; Video-interviews with agile development practitioners.	2-3 MINUTE VIDEO DEEP-LEARNING PEER REVIEW PROJECT-BASED LEARNING
Topic: Bootstrap - User Interface Prototyping		
Identify the concepts related to the use of Bootstrap; Prototype and implement the main user interfaces related to the viable minimum version of your project.	Demonstration video about Bootstrap: guide of installation, configuration, among other features; Hands-on activities related to paper prototypes and implementation of user interfaces by using Bootstrap.	ATTRACTIVE SCREENCAST DEEP-LEARNING CHECKPOINT SELF-REFLECTION
Topic: CodeIgniter - Backend		
Identify the concepts related to the use of CodeIgniter; Prototype and implement the backend related to the viable minimum version of your project; Implement the integration between Bootstrap and CodeIgniter considering the code developed for your project.	Demonstration video about CodeIgniter: guide of installation, configuration, among other features; Hands-on activities related to the integration of backend (CodeIgniter) and frontend (Bootstrap); Testing activities: lecture and hands-on activities.	ATTRACTIVE SCREENCAST DEEP-LEARNING CHECKPOINT SELF-REFLECTION

Topic: Additional Resources		
Identify additional code resources, new functionalities or new viable minimum versions to be implemented in your project.	Demonstration videos and texts to support the students in the selection and development of new functionalities for their projects.	ATTRACTIVE SCREENCAST CHECKPOINT
Topic: Delivery of the Practical Project and Pair-Evaluation		
Test the design and deliver the viable minimum version of the project constructed during the course; Judge the version shared by other collegues using a specific rubric.	Demonstration report about hosting applications on the web using free resources; Pair-evaluation of the practical projects delivered by the end of the course.	PEER REVIEW
Topic: Consolidation and Experiences		
Compare your software version to your collegues' versions; Value and critique your performance in the course.	Post-test; Final self-evaluation; Course evaluation.	PRE AND POST TEST SELF-EVALUATION

Source: Elaborated by the author.

6.2.3.3 *Development*

Specific videos were recorded and edited using the IFSULDEMINAS Campus Muzambinho media service. The videos were developed considering best practices to produce multimedia online videos for MOOCs (2-3 MINUTE VIDEO). Furthermore, all the learning materials used in the course, such as videos, images and texts, were based on the OER-MADE MOOC pattern related to Open Educational Resources. Finally, the Learning Map (Table 37) was implemented in Tim Tec platform, according to the DEVELOPMENT and DELIVERY PATTERNS categories (Figure 37).

Figure 37 - Module 1 topic headings as displayed in MiríadaX.

Source: MiríadaX.

Before launching the MOOC, the MiríadaX Teaching and Learning team analyzed it and sent us a report with recommendations. This allowed us to improve the course before it reaches hundreds of users.

6.2.3.4 *Delivery*

The course was launched in November 2017 and stayed online for six weeks. When the course opened, only the first module, named “Before starting the Course”, was released. It was reserved to introduce some initial questions to motivate registered users to reflect on concepts to be worked during the course, to conduct a pretest, and to regulate students’ learning process.

It was mandatory to conclude the first module to advance the course and access the remaining modules. Despite such requirement, the students were free to complete the course at their own pace.

6.2.3.5 *Evaluation and Improvement*

The opportunity of launching one MOOC through MiríadaX gave us a route to experimentation with the application of the LDF4MOOCs framework to design a course at large scale and explore more possibilities in this area.

The first edition of the course had around 665 enrolled students. From those, 465 (69.92%) effectively began the course. 44 of them (9.5%) reached the last week. From those, 15 (34%) achieved all the requirements to receive a certificate, i.e., a completion rate of 3.22%. The requirements were: watching the required videos, performing compulsory tasks, delivering the proposed software, and attending a pair-evaluation, according to the MOOC Learning Map (Table 38).

Regarding the Geographical distribution, 661 of the 665 registrants identified their locations (Figure 44). They were drawn from different countries of the world, according to Table 38.

Table 38 - Geographical distribution.

Country	Participants
Brazil	312 (47.2%)
Spain	106 (16%)
Peru	61 (9.2%)
Mexico	33 (5%)
Colombia	25 (3.8%)
Ecuador	24 (3.6%)
Argentina	23 (3.5%)
Venezuela	18 (2.7%)
Others	9%

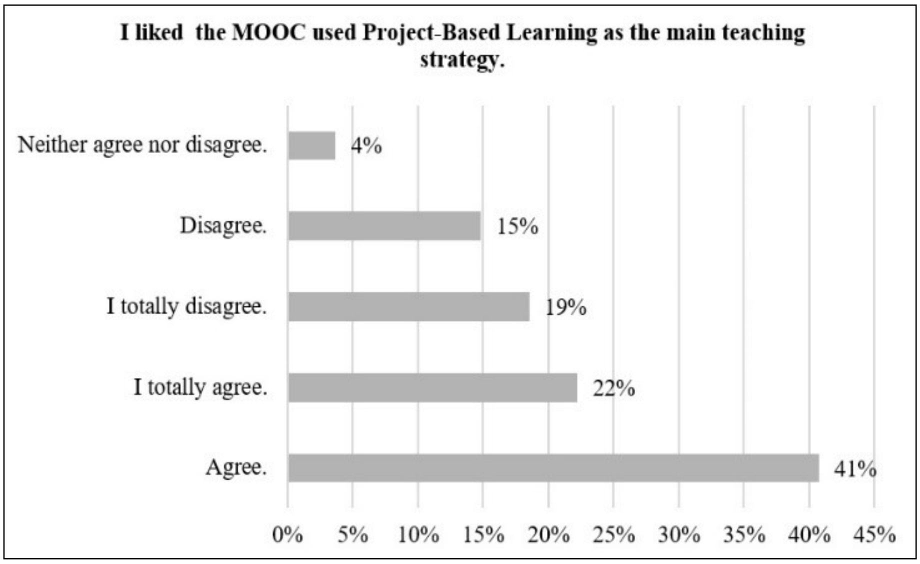
Source: Elaborated by the author.

Regarding the personal characteristics, of the 186 registrants who identified their genre, 82.2% were male and 17.8% were female. Of the 174 participants who identified their age, 39.7% were between 25 and 34; 23.6% were between 18 and 24; 21.3% were between 35 and 44; 11.5% were between 45 and 54, and 4% were between 55 and 64 years old. Of the 171 participants who identified their educational or professional qualifications, 47.4% were undergraduate students; 31.6% had an undergraduate education, 14.6% were teachers or researchers in universities; 4.1% were university staff (administrative work), and 2.3% had a high school education.

In addition to the social and demographic data analysis, we verified the students' opinion about interventions and design decisions made for the related MOOC. The questions were grouped into eight dimensions by considering the desired characteristics for MOOC Learning Maps, i.e., MOOC projects (Section 5.4) and in the *Instrument to Support the Evaluation of Learning Maps in the MOOC Context* (Appendix C). Some questions with positive answers are briefly described next.

- I liked the MOOC used Project-Based Learning as the main teaching strategy (Competency-based design) (Figure 38).
- I liked the course contemplated a teaching process more oriented to the achievement of practical activities than theoretical exposition of content (User-centered learning).
- I liked the course used short videos (1 to 5 minutes) to guide the students in the activities that should be developed (User-centered learning).
- I felt engaged, motivated and able to manage my own learning (Self-regulation learning).

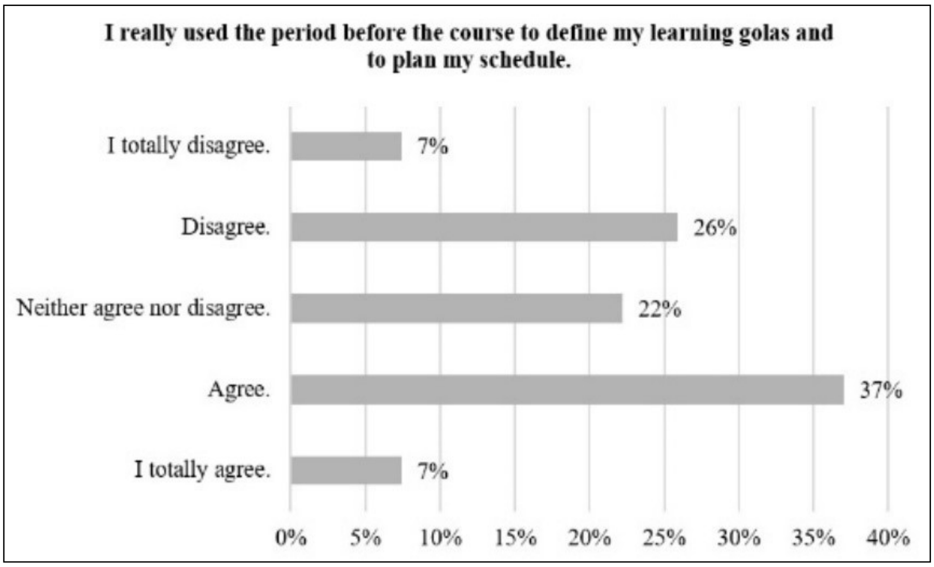
Figure 38 - Students' impressions about the use of Project-based Learning as teaching strategy.



Source: Elaborated by the author.

In our MOOC, we used different strategies to encourage self-regulated attitudes towards learning. For instance, the students were asked about "*Have you specified one or more learning goals you want to achieve by the end of the course? No? So, try to complete the sentence: By the end of the course, I hope to learn or be able to do X, with the purpose of Y (e.g., apply in my work, develop a school task, improve my knowledge in order to get a job). For this, I will use the following Z strategies (e.g., study two hours a week, improve my time management, set* *priorities).* However, when students were asked about the effective definition of learning goals to be achieved by the end of the course, we identified an irregular distribution in the related answers (Figure 39). Students had difficulty to define their learning goals, manage time and control their own learning process. This gap deserves special attention by instructors and demands further investigation. MOOC platforms also need to consider new features to support self-regulation learning.

Figure 39 – Students' Impressions about the effectiveness to define goals.



Source: Elaborated by the author.

In addition to acting as a way to validate and refine the LDF4MOOCs framework, from this case study we also evidenced that there are still several technological and pedagogical challenges that need to be addressed so as to enhance the learning experience for web development education-based MOOCs. For instance: (i) aligning the MOOC syllabus with students and job market' needs is essential but challenging; interventions need to be performed in order to keep the course open to everyone; (ii) in our MOOC, students had difficulty to define their learning goals, manage time, and control the own learning process; this gap deserves special attention by instructors and demands further investigation; and (iii) MOOC platforms also need to consider new features to support self-regulation learning and collaborative activities that involves programming topics, among others.

Finally, it is important to highlight that, even though web programming has become a dominant programming model, according to Miller and Connolly (2015) it still seems underrepresented as a curriculum topic within many computing programs. Such issue in web development education is not recent and was evidenced, for instance, by (LIM, 1998), which highlighted that Computer Science and Information Systems departments needed to re-examine their curricula in order to prepare students to face the challenge of not only being able to function in a traditional data processing environment, but also be productive in a computing world that is now swamped with web technologies.

6.2.4 **Case Study 3: *Introduction to Software Testing***

This section describes the *Introduction to Software Testing* MOOC*,* which was also designed based on the LDF4MOOCs framework. The following sections are organized according to the main phases defined in the MOOC Life Cycle Process (exploration, planning, development, delivery, and evaluation/improvement).

6.2.4.1 ***Exploration***

We used the EXPLORATION PATTERNS category to frame the initial idea of our proposal. For example, from the patterns BROWSE EXISTING MOOCS FOR INSPIRATION and KNOW YOUR LEARNERS we identified that software testing is an important activity to ensure quality for software products. Thus, software development companies have increased the demand for professionals and practitioners with knowledge and skills in Software Testing. However, there is a lack of qualified professionals associated to the lack of motivation to work with software testing (VALLE; BARBOSA; MALDONADO, 2015). We also identified the main approaches of teaching software testing but in face-to-face courses (VALLE; BARBOSA; MALDONADO, 2016). Furthermore, according to our previous studies (FASSBINDER et al., 2017), MOOCs in Software Testing Education are still under investigated.

6.2.4.2 ***Planning***

According to the ENGENDERING TEAMWORK pattern, building a MOOC is a team effort and requires individuals with complementary skills and expertise. In this MOOC, we rely on several professionals and researchers involved with activities of Verification, Validation, and Testing (VV&T). Around 11 people were involved with the course: five instructors, three invited guests from the academia and the market, one digital media technician, one Project Manager (USP-Coursera), and one tutor. We used LEARNING MAP CREATION to support the team work.

CASE-BASED LEARNING was used as the main active learning strategy to guide activities in the platform (e.g., videos, activities, examples). In addition, PROJECT-BASED LEARNING was applied to encourage deep learning and the application of the learned content in real scenarios. The main topics and activities of the learning map are summarized in Table 39.

Table 39 - Learning Map of the *Introduction to Software Testing* MOOC.

Objectives	Main Activities	Main patterns considered
Topic: Before starting the Course		
Remember the current knowledge on the subject, before the course starts; Set your own goals to obtain knowledge and develop skills during the course; Identify how the course works and the involved instructors.	*Lecture*: Course's overview; *Reading*: Target public of the course; *Quiz*: Why did you join the course?; *Reading*: Towards the final practical activity; *Lecture* and Reading: Information about the instructors; *Quiz*: Setting learning goals; *Quiz*: Initial Self-evaluation; *Quiz*: Pre-test; *Discussion prompt*: Presentation and initial question.	BEFORE THE COURSE STARTS STUDENT MINERS SELF-EVALUATION PRE AND POST TEST MOOC COMMUNITY FORUM
Topic: Welcoming		
Recognize the teachers and other professionals involved in the course; Identify the general concepts of the Software Testing Activity: history, characteristics of professionals, preliminary concepts; Examine the key challenges related to the Software Testing Activity in your context; Realize why Software Testing is so important.	*Lecture*: A short-history of Software Testing; *Reading*: Why the Software Testing activity is so important?; *Reading*: TMMI; *Lecture*: Invited guest to talk about TMMI; *Reading*: Characteristics of good testers; *Lecture*: Invited guests to talk about characteristics of Software Testing professionals; *Lectures and Readings*: Preliminary concepts.	2-3 MINUTE VIDEO WELCOMING VIDEO CASE-BASED LEARNING IN-VIDEO QUESTION
Topic: Functional Testing		
Identify the context in which the Functional Testing technique is inserted; Distinguish its main criteria; Apply the Functional Testing technique and its main criteria to solve cases.	*Lectures and Readings*: Overview and criteria (Equivalence Partitioning and Boundary Value Analysis); Tools and test automation; *Quiz*: Check your progress in the course; Discussion prompt: Functional Testing automation.	CASE-BASED LEARNING 2-3 MINUTE VIDEO QUIZ SELF-EVALUATION IN-VIDEO QUIZ MOOC COMMUNITY FORUM
Topic: Structural Testing		
Identify the context in which the Structural Testing technique is inserted; Distinguish its main criteria; Apply the Structural Testing technique and its main criteria to solve cases.	*Lectures and Readings*: Overview and criteria (Control and data flow); Tools and test automation; *Quiz*: Check your progress in the course; Discussion prompt: Structural Testing automation.	CASE-BASED LEARNING 2-3 MINUTE VIDEO QUIZ SELF-EVALUATION IN-VIDEO QUIZ MOOC COMMUNITY FORUM
Topic: Defect Based Testing		
Identify the context in which the Defect Based Testing technique is inserted; Distinguish its main	*Lectures and Readings*: Overview and criteria (Mutation testing); Tools and	CASE-BASED LEARNING 2-3 MINUTE VIDEO

criteria (Mutation testing); Apply the Mutation testing to solve cases.	test automation; *Quiz*: Check your progress in the course; Discussion prompt: Mutation testing automation.	Quiz Self-evaluation In-video quiz MOOC Community forum
Topic: Practical Module		
Create a document containing the planning, execution and evaluation phases of the Test Activity for one scenario chosen by the student; Select the main techniques and test criteria to apply to a scenario; Compare which techniques, criteria and tools can be applied to conduct the test activity in a given scenario; Apply such techniques and criteria; Judge the proposals sent by other learners, considering the rubrics (requirements) defined by the instructors.	*Lecture*: Invited guests to talk about Quality Assurance; *Lecture*: Information about the Practical Module; *Peer Review*: Solving cases involving Software Testing; *Lecture*: Final reflection about your self-regulation learning process; *Quiz*: Post-test; *Quiz*: Self-evaluation; *Quiz*: Final feedback about the course; *Lecture*: Invited guest to talk about the future of Software Testing.	Project-Based learning Case-Based Learning 2-3 Minute video Quiz Self-evaluation Post-Test Self-Reflection Peer Review

Source: Elaborated by the author.

6.2.4.3 *Development*

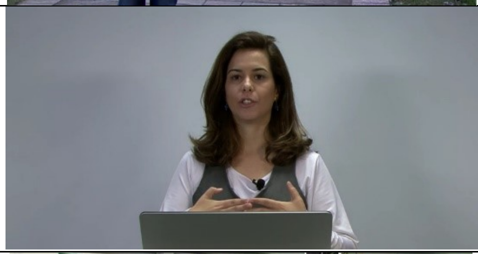
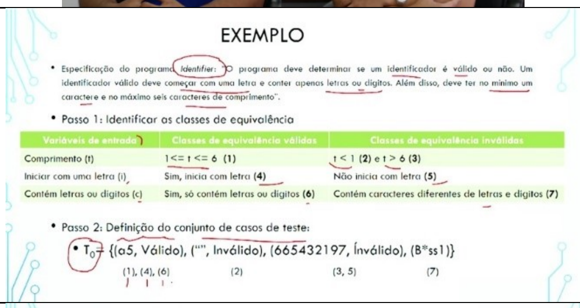
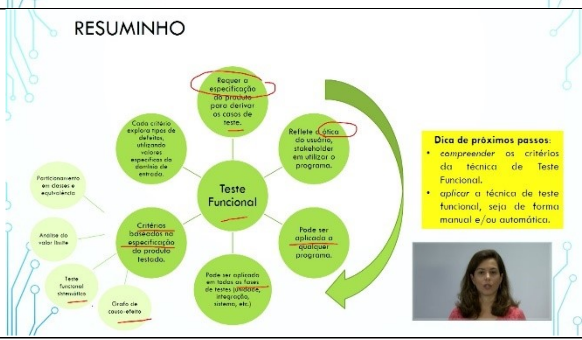
In the development phase, videos were specifically created for this MOOC due to the difficulty to find adequate open educational videos, i.e., with short duration, in Portuguese, and configured with open licenses. The videos were recorded and edited using the USP media service support, having the patterns OER-made video, 2-3 minute video, Attractive Screencast, and Authoring rights as support.

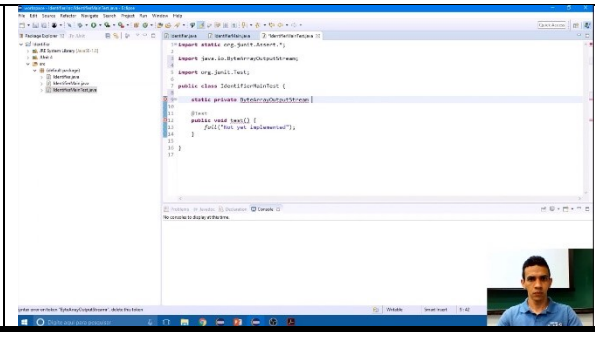
In general, we have used different instructional video styles in our MOOC (SANTOS-ESPINO; AFONSO-SUÁREZ; GUERRA-ARTAL, 2016), such as summarized in Table 40.

Table 40 - Video styles used in the *Introduction to Software Testing* MOOC.

MOOC video styles in this MOOC	Examples
Video generated from authoring tools (e.g., Powtoon[71]).	

[71] https://www.powtoon.com

<table>
<tr><td>Talking head in a natural setting.</td><td>
</td></tr>
<tr><td>Talking head in artificial setting (studio).</td><td></td></tr>
<tr><td>External recording; interview (declarative); with a market professional in her workspace.</td><td>
</td></tr>
<tr><td>External recording, interview (declarative), with two professionals in scene, in their workspace.</td><td>
</td></tr>
<tr><td>Screencast (slides)</td><td>
</td></tr>
<tr><td>Head and Slides.</td><td>
</td></tr>
</table>

Head and Screencast (coding)	

Source: Elaborated by the author.

Having the MOOC Setup and Review and early feedback patterns in mind, we invited the staff to provide early feedback on course materials in development. Coursera platform provided an automated pre-launching check. Such functionality verifies if the first session date is set; the course has a designed instructor; the course settings (e.g., course logo, topic areas) are in place and correct; among others.

6.2.4.4 *Delivery*

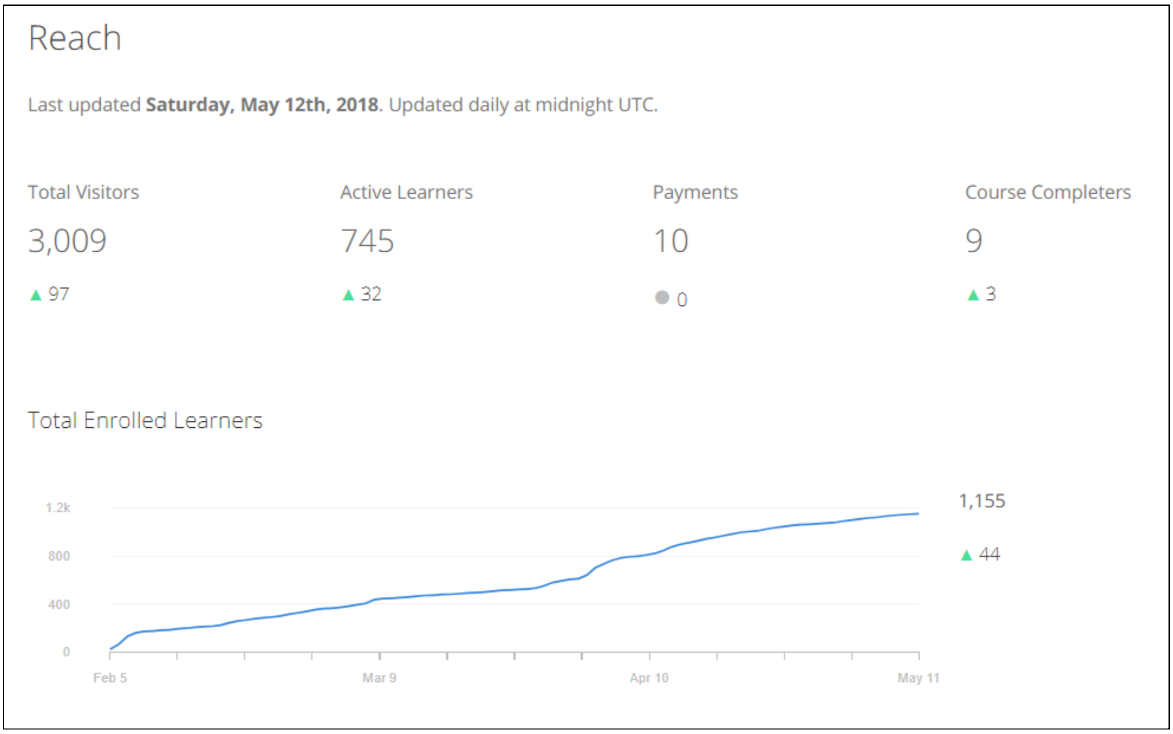
Considering the Launch and promote your MOOC and Announcements and Messages patterns from the Delivery Patterns category, the first session of the course was launched in February 2018. On Coursera platform, all courses are in session format. Each session has a start and end date, with a weekly schedule of suggested deadlines. Learners in the same session work through the course together. After the instructor setting the first session, Coursera will automatically set session start dates on a regular schedule (each four weeks, in general). Enrollment for each session also opens and closes automatically. Feedback with the MOOC in execution was considered by the instructors and the tutor in order to clarify points that have generated doubts among the learners

6.2.4.5 *Evaluation and Improvement*

The opportunity of providing *Introduction to Software Testing (CS3)* through the Coursera platform gave us the opportunity of making part of an international community of partners, and having access to technical and pedagogical guidelines, such as the Coursera pedagogical checklist and best practices to create educational videos.

Following we present the learning analytics data on the MOOC's reach, considering the period of February 2018 to early May 2018 (Figure 40). *Leaner* is any registered Coursera user. *Total Visitors* are registered Coursera users (mobile and web) who visited the course since it started. *Active learners* are unique enrolled learners who viewed a reading or discussion, began watching a video, or began an assessment; includes both mobile and web users. *Course Completers* are learners who have passed every graded assessment.

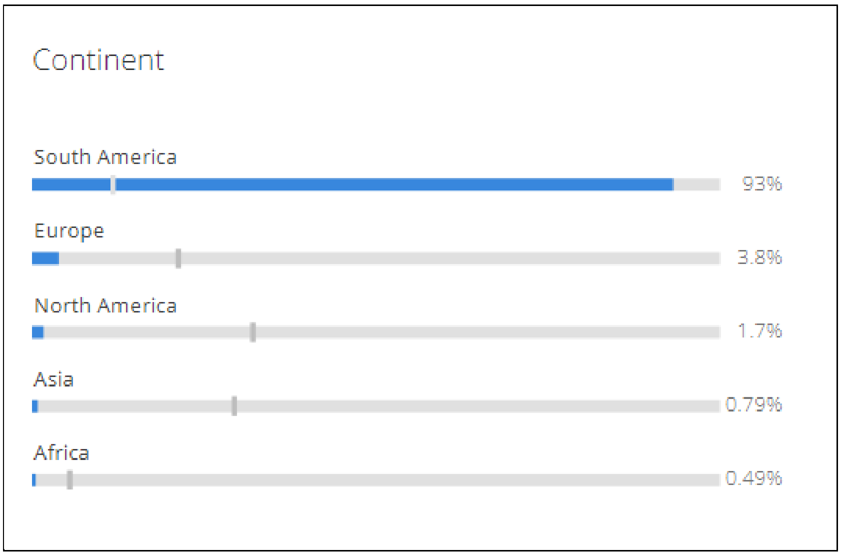
Figure 40 - Overview of the number of accesses and the reach of the course.



Source: Data provided by Coursera.

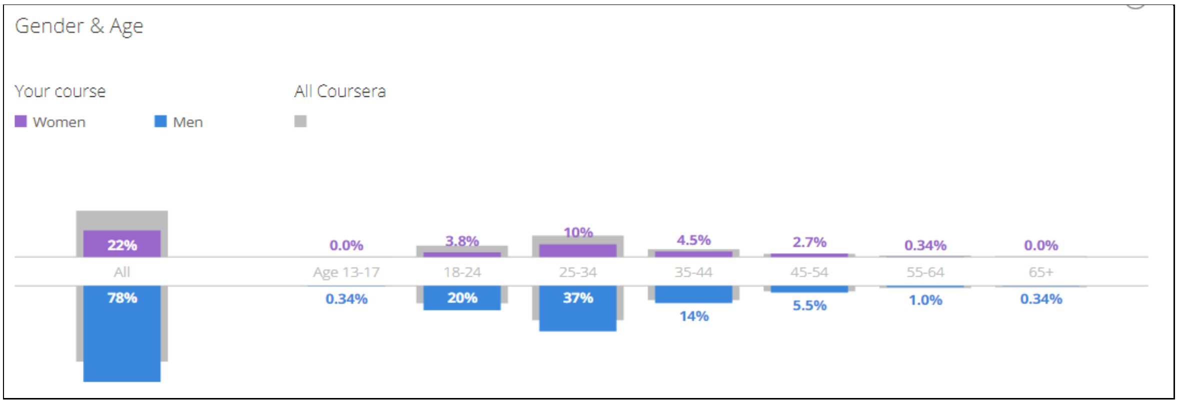
The demographic information of our MOOC learners relies on two sources: (i) geographic location was estimated based on IP address; and (ii) the rest of demographic data i.e. age, gender, highest education and occupation was obtained from Coursera entry survey. Figures 41, 42 and 43 are based on data from 1,014 learners. Accuracy depends on the number of enrolled learners who have completed the profile or survey. The 95% confidence interval for each chart is specific to this course.

Figure 41 - Location data.



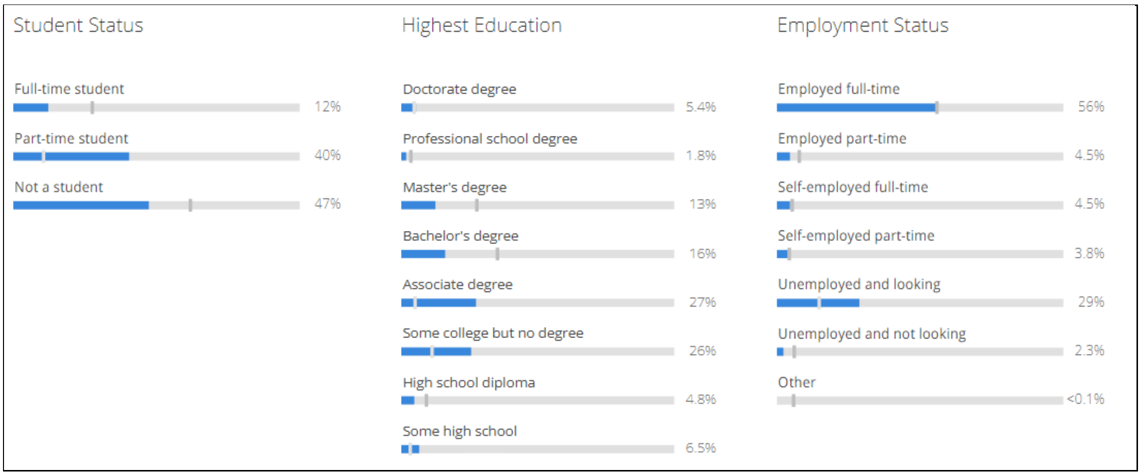
Source: Data provided by Coursera.

Figure 42 - Gender and Age data.



Source: Data provided by Coursera.

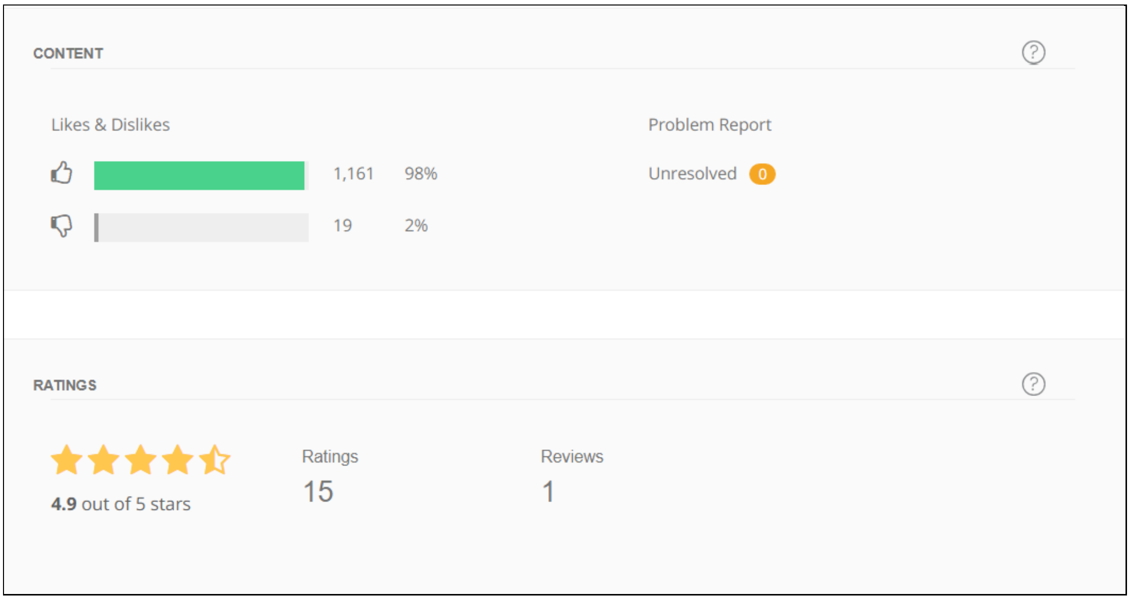
Figure 43 - Other demographic data.



Source: Data provided by Coursera.

Figure 44 shows the current ratings for the *Introduction to Software Testing (CS3).* Learners like (give thumbs up) or dislike (give thumbs down) to individual items to indicate their enjoyment of the content, or how helpful it was to them. Learners can also report problems (flags) to suggest improvement on the content. Learners can rate the course at any point as they progress but must be enrolled to rate a course.

Figure 44 - Ratings for the Introduction to Software Testing MOOC.



Source: Data provided by Coursera.

Recall and understanding of the subject matter was measured with a pre-test (7 items) and a post-test (7 items) administered at the beginning and at the end of the course. The post-test was similar in content and format to the pre-test but the multiple-choice items in both tests were unique for each test. Students, for example, were asked to answer questions such as *"A program receives an age and must return if the related individual is under age or not. Considering Functional Testing, choose the incorrect answer: (a) the ordered pair (2, under age) is an example of a valid test; (b) 70 belongs to the entry domain; (c) 'to be of age' and 'under age' are examples of the output domain; among other options".* The pre-test and the post-test performance scores were determined by computing the average score for the remaining seven items. As a result, the post-test score was 17% higher than the pre-test.

Ratings and stories provided us with direct feedback from learners. This was especially valuable in helping us improve the learner experience in our course. Based on this feedback, we revised the materials and fixed errors.

Through the course dashboard we only had access to the data previously described. However, Coursera platform provides a self-service data exports supplement. Such data contain sensitive information to protect learners' privacy and security. Research data exports are sets of CSV files, designed for use in relational database systems. As future work we intend to use techniques of Learning Analytics to analyze such data and identify the impact of the MOOC design on learners' outcomes.

6.2.5 Meta-MOOC 2: *Creating Learning Projects for MOOCs*

Creating Learning Projects for MOOCs was also delivered in the IFSULDEMINAS context (i.e., the Tim Tec platform) and designed through the guidance of LDF4MOOCs. The course approaches how to design a MOOC by using LDF4MOOCs.

6.2.5.1 *Exploration*

The course was planned for three main reasons: (i) to support the IFSULDEMINAS' instructors who were attending a selective process[72] to design MOOCs; (ii) to present LDF4MOOCs to the subjects who participated in the Field Evaluation, as described further in Section 6.4; and (iii) to share our findings and the LDF4MOOCs framework with the community.

6.2.5.2 *Planning*

The main pedagogical strategy used to design this MOOC was Project-Based Learning. In fact, this course required from leaners the development of a MOOC Learning Project in two different ways: one without any support (i.e., on an ad hoc basis) and other by having the LDF4MOOCs framework as a guide.

Table 41 summarizes the main topics, learning outcomes (goals), activities as well as the main patterns considered to design the *Creating Learning Projects for MOOCs* course.

Table 41 - Overview of the Learning Map: *Creating Learning Projects for MOOCs* course.

Topic	Goals	Main Activities	Patterns considered
Before the Course	Remember (define, list). Create (design, formulate). Evaluate (judge).	Facilitator's presentation; Overview of the course; Research and ethical use of the collected data; Leaners' background questionnaire; Creating and managing your daily board; Creating your MOOC project outline on an ad hoc basis; Sharing your	PROJECT-BASED LEARNING DEEP LEARNING VARIETY OF SOLUTION AND EXAMPLES STUDENT MINERS SELF-EVALUATION 2-3 MINUTE VIDEO

[72] https://www.ifsuldeminas.edu.br/index.php/noticias/1321-cursos-moocs

		project outline using Google Drive; Self-evaluation of the MOOC project outline.	
Considerations	Understand (identify).	Reflection about the "Before the course" class; How the Tim Tec works; Additional videos and readings.	Checkpoints 2-3 Minute Video Self-reflection
Strategies to Design MOOCs	Understand (identify, recognize). Analyze (differentiate). Create (design).	Overview of the main strategies that can be used to design MOOCs; A Learning Design Framework for MOOCs; First steps regarding the use of the Framework; Creating the MOOC Learning Map and video scripts using the Framework as a guide.	Project-based Learning Deep Learning Variety of solution and examples Student Miners
Supporting Videos	Understand (identify).	Using the Learning Map artifact; Using the Bloom's Taxonomy to defined learning outcomes; Webinar to clarify doubts.	2-3 minute video MOOC community forum
Delivering and Evaluating Learning Maps and Script Videos.	Analyze (examine, compare, contrast). Evaluate (judge, critique).	Self-evaluation of the MOOC Learning Map; Delivering/Sharing the map with the other students; Pair-evaluation of the maps; Sharing the video scripts; Pair-evaluation of the video scripts; Final considerations.	Self-evaluation Deep-learning Peer review Variety of solution and examples

Source: Elaborated by the author.

6.2.5.3 *Designing*

Considering our previous experiences from designing and delivering the first MOOCs, we identified some issues which can hinder the individual production of MOOCs, or even their development by small MOOC teams, such as: (i) lack of infrastructure (e.g. studio, prompter, video editing software); and (ii) the lack of knowledge about types of videos and their production, limited budget, among others.

Thus, for this specific course we decided to record only educational homemade videos, in order to motivate the participants in creating their own videos for their own MOOCs. We used the OBS Studio[73], a free and open source software for video recording and live streaming, in order to create the internal content of the course. Also used the free version of the webtool Powtoon[74] to create an animated presenting video[75].

Beyond the videos, MOOC participants had access to the framework by the address http://caed.icmc.usp.br/mooc. Additional web formularies were also created to collect additional data (e.g., learners' background).

6.2.5.4 *Delivery*

The course was first launched in July 2016 and stayed online for 6 weeks in the Tim Tec MOOC platform. At that time, a total of 160 users have registered for the course.

When the course opened, only the first lesson was released. The remaining of classes were released after two weeks. Although learners were encouraged to follow the prescribed timeline of activities, they were free to complete the course at their own pace.

The first two weeks were mainly reserved to introduce some initial questions to learners and to guide them to create a MOOC Project Outline about any subject and on an ad hoc basis (i.e., without any initial support). After these two weeks, the learners had the first contact with the LDF4MOOCs framework and its elements, and used them to effectively design their MOOC Learning Maps, considering the same subject used to create the previous MOOC Project Outline. They had other two weeks to complete this task.

6.2.5.5 *Evaluation and Improvement*

Some of the main findings from the course evaluation phase are presented following.

The completion rate stayed around 9.5%. About 44% of the participants enrolled in the course did not even begin it, and nearly 46.5% started but did not finish it.

Regarding the participants who did not complete the course (90.5%), almost 22% attended a questionnaire specially created to identify the drop-out causes. The main reasons pointed out to not finish the course were: lack of time, other activities with higher priority, and personal or health problems. Nevertheless, near 77.1% intend to attend the course in an upcoming deliver.

---

[73] https://obsproject.com/download.
[74] https://www.powtoon.com/home.
[75] https://www.youtube.com/watch?v=z9v96Ks8aFs

Considering the participants profile, most respondents were female (54.3%), as presented in Table 42. Regarding the academic background, their higher academic degrees were: specialization (25.7%), master (20%), college in progress (14.3), Ph.D. (11.4%). Regarding the age group, most respondents (45.7%) had between 25 and 34 years, as also presented in Table 42.

Table 42 – Participants of the course (in %).

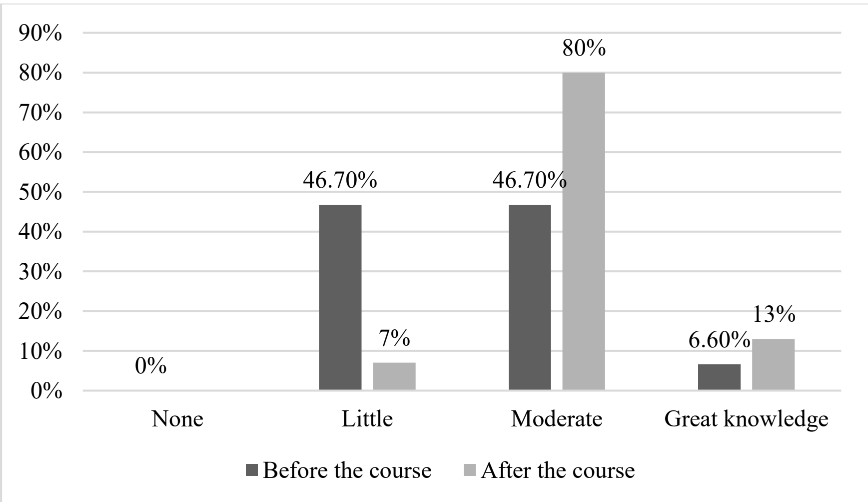
Gender		Age					
Fem.	Male	18-24	25-34	35-44	45-54	55-64	65-
54.3	45.7	8.6	45.7	25.7	11.4	5.7	2.9

Source: Elaborated by the author.

Furthermore, the occupation distribution can be characterized as teachers (61%); market professionals (25%) such as programmers and learning designers; university staff (10%), such as psychologists, tutors, and learning designers; and students from face-to-face courses (4%).

Regarding the knowledge about educational design patterns accumulated by the concluding participants through the course, Figure 45 highlights that they expanded their knowledge on it.

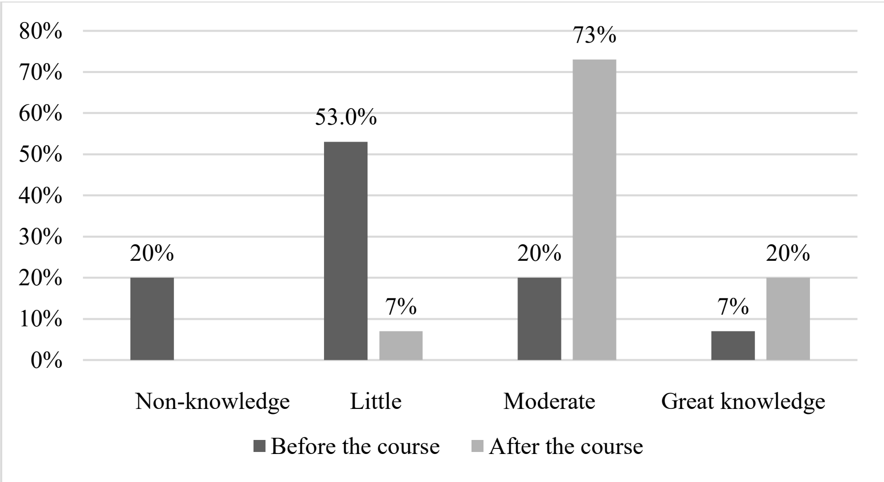
Figure 45 - How the MOOC’ participants defined their knowledge about Educational Patterns before and after the course.



Source: Elaborated by the author.

Figure 46, in turn, presents the concluding participants’ distribution of knowledge on MOOC design before and after the course. Before the course, the knowledge is concentrate in the lower levels (non, and little). This scenario is different by the end of the course, when most of them declared themselves with moderate or great knowledge on MOOC design.

Figure 46 - How the MOOC's participants defined their knowledge about MOOC design before and after the course.



Source: Elaborated by the author.

When asked if the personal learning goals defined at the beginning of the course were achieved, most of the respondents said 'yes', according to Table 43. For those who said 'not yet', the main reasons were: lack of time and dedication, big amount of content, and lack of clarity in some activities.

Table 43 – Goals achievement (in %).

Goals achievement			
Not yet	Yes, some of them	Yes, partially	Yes, completely
15.3	46.2	15.4	23.1

Source: Elaborated by the author.

Other relevant findings are presented in Section 6.4, since the course was developed mainly to support the field evaluation that was performed.

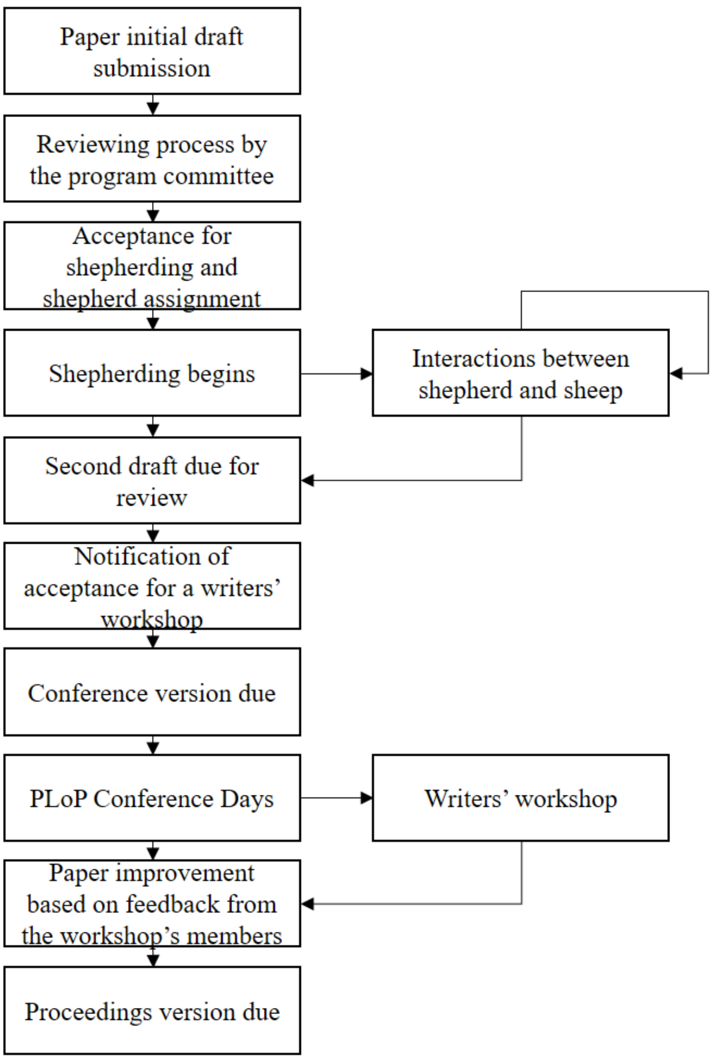
6.3 EXPERTS REVIEW

This section describes two types of expert reviews performed as internal validation methods. One with patterns specialists who focused on the patterns content and the pattern language structure, and one with learning designers who explored pedagogical aspects of the framework by considering learnability, effectiveness and use satisfaction.

6.3.1 Patterns Specialists

The main element of the LDF4MOOCs framework is an Educational Design Pattern Language. As emphasized in Section 5.3, where we presented an overview of the development process of the framework's pattern language. Braga (2003) highlights that the community of patterns recommends that pattern languages be submitted to Pattern Languages of Programs (PLoP) Conferences, since such events offer special reviewing process (Figure 47) and support for authors who want to receive peer feedback by fellow authors with experience in pattern writing.

Figure 47 - Example of review process in a PLoP Conference.



Source: Elaborated by the author based on http://www.hillside.net/plop/2017/.

PLoP conferences annually take place in different cities around the world and the most relevant are: PLoP[76] (since 1994 in the USA), EuroPLoP[77] (since 1995 in Europe), and SugarLoafPLoP (since 2001 in Latin American). A list of other related events can be found at http://hillside.net/conferences. They traditionally provide opportunities to gather, discuss,

[76] http://www.hillside.net/plop
[77] www.europlop.net/

share, and learn more about patterns related to different contexts, such as software development, educational, among others.

Our Pattern Language (and its patterns) was refined under a shepherding process and presented in a writers' workshop during the 24th International Conference on Pattern Language of Programs, organized by the Hillside Design Patterns community[78], in October 2017, Vancouver, Canada. The main results are presented in (FASSBINDER; BARBOSA; MAGOULAS, 2017b).

According to Harrison (1999), 'shepherding' is a period for improving patterns by interacting with a 'shepherd' specially assigned to evaluate the paper. As a reaction to the shepherd's comments, authors create a new version of the related papers and patterns.

During the conference, all accepted papers are reviewed in *Writers Workshops*. According to Coplien (1997), the objective is to acquire as much feedback for constructive improvement of the reviewed patterns and pattern languages as possible. Papers are discussed individually, in a session of about one hour, which contributes greatly to its improvement.

In our writer's workshop session, six experienced pattern writers (Table 44) noticed that: (i) the PL graph should be better described (e.g., description of arrows); (ii) new patterns could be considered, such as a pattern about How to build a MOOC team related to the Engendering Teamwork pattern; (iii) some patterns content should be rewritten; (iv) the patterns should be mapped into the MOOC Life Cycle; and (v) more concrete examples should be described. The experience acquired from our attendance in the PLoP conference was used to improve the patterns and the related paper.

Table 44 - Experienced pattern writers' profile who attended the session discussion of our PL.

Experts in Learning Design	Position	Experience (year)	Expert fields
Expert 1	M.Sc. in Computer Science.	5	Software Engineering applied in Education.
Expert 2	Software Engineer.	25	Computer Science.
Expert 3	Professor of management.	22	Patterns into organizations.
Expert 4	Object Oriented Developer.	32	Computer Science and Mathematics.
Expert 5	Computer Scientist.	32	Computer Science and Mathematics.
Expert 6	Lecturer, Researcher, Consultant.	21	Management; Systems Science and pattern Literacy.

Source: Elaborated by the author.

[78] http://www.hillside.net/plop/2017/index.php?nav=program

6.3.2 Learning Design Specialists

An expert review method was conducted from September 2017 up to December 2017 to verify if Learning Designers (LDs), also named Instructional Designers (IDs), would be able to apply the LDF4MOOCs framework to design a MOOC by simulating a real-world situation. The assumption was that the experts could simulate the role of people interested in designing MOOCs by testing pedagogical usability aspects of using the framework to design MOOCs and provide us with information about the framework's validity as well as suggestions for future improvements.

According to Nokelainen (2006), pedagogical aspects of designing or using digital learning material are much less frequently studied than technical ones. For the author, a technical usability evaluation is guided by the assumption that it should be easy to learn to use the central functions of a product, and its functions are efficient and convenient in use. However, when evaluating pedagogical usability, the assumption is that the learning designers, or other practitioners, should be guided by either a conscious or subconscious idea of how the functions of the tested product (e.g., the framework) facilitate the learning of (or in) the material that is being delivered (e.g., a MOOC built by using the framework).

A range of strategies was adopted to invite experts from various backgrounds (e.g. educational technologists, e-learning managers, tutors, professors). However, experience in designing virtual courses (open and massive, or not) was a mandatory requirement to attend the test. Two e-mail lists related to the theme[79] were used to invite experts. In addition, we also shared posts in social groups. To reach more volunteer specialists, a communication channel through the University of Itajubá (UNIFEI) was also used[80]. Such institution offers a recognized specialization course in e-learning design named *Design Instrucional para EaD Virtual*.

The experts review contained the following steps:

(1) the purpose and the tasks for the pedagogical usability evaluation were explained through a protocol and sent by e-mail for those who accepted the invitation to attend the activity;

(2) the experts were asked to fill out a background questionnaire;

---

[79] ead-l@listas.unicamp.br and sbc-ie-l@sbc.org.br

[80] https://www.facebook.com/universidadefederaldeitajuba/posts/1450405378407768 and https://nead.unifei.edu.br/noticias/254-convite-para-designers-instrucionais-participarem-de-teste-de-usabilidade-pedagogica

(3) they had to interact with the LDF4MOOCs framework[81] and understand its elements on their own;

(4) they had to use the framework to create a MOOC Learning Map about any subject, i.e., topic, from their natural places of work (i.e., at school or at home), wherever and whenever was more convenient to them;

(5) after using the framework to develop a MOOC Learning Map, the learning designers were asked to self-evaluate such map by using the *Instrument to Support the Evaluation of Learning Maps in the MOOC Context* (Appendix C);

(6) to conclude, they were asked to complete a pedagogical usability evaluation questionnaire[82]. The questions of such questionnaire were developed with reference to (KIM; JIN, 2015, pp. 66) and were organized using the following three categories: learnability (two multiple-choice questions), effectiveness (eight multiple-choice questions) and satisfaction (two multiple-choice questions), totaling twelve multiple-choice (all single answer) questions, according to Table 45.

Table 45 - Questions of the pedagogical usability evaluation questionnaire.

Category	Questions
Learnability	Q1.1 The proposed LDF4MOOCs was easy to comprehend.
	Q1.2 I can easily design a MOOC Learning Map having the framework's guidance.
Effectiveness	Q2.1 The proposed framework is helpful in designing MOOC Learning Maps to improve competency-based learning.
	Q2.2 The proposed framework is helpful in designing MOOC Learning Maps to improve user-centered learning.
	Q2.3 The proposed framework is helpful in designing MOOC Learning Maps to improve self-Regulated learning.
	Q2.4 The proposed framework is helpful in designing MOOC Learning Maps to improve social networking and collaborative learning.
	Q2.5 The proposed framework is helpful in designing MOOC Learning Maps to improve deep learning, knowledge creation and sharing.

[81] Available at caed.icmc.usp.br/mooc
[82] Available at https://goo.gl/forms/TfSJ1Ci1VPVJWqpB3

	Q2.6 The proposed framework is helpful in designing MOOC Learning Maps to improve assessment and understanding.
	Q2.7 The proposed framework is helpful in designing MOOC Learning Maps to accommodate differences.
	Q2.8 The proposed framework is helpful in designing MOOC Learning Maps to improve feedback.
Satisfaction	Q3.1 I am satisfied with designing a MOOC Learning Map according to the proposed framework.
	Q3.2 When designing MOOC Learning Maps in the future, I would like to apply the suggested framework.

Source: Elaborated by the author.

The learnability category measures how easily the experts understood and applied the framework to design a MOOC Learning Map. The effectiveness category measures the experts' viewpoint about the helpfulness of the framework when someone (e.g. learning designer, instructor) is designing a MOOC. The satisfaction category gauges the experts' satisfaction when applying the framework to design MOOCs. The effectiveness-related questions were based on the eight dimensions of the *Instrument to Support the Evaluation of Learning Maps in the MOOC Context* (Appendix C).

For each question, a five-point scale ranged from 1 (totally disagree) to 5 (totally agree). For each category (i.e., learnability, effectiveness, and satisfaction) the participants had the opportunity to write free texts and justify their answers. Finally, they also had chance to write their impressions about the individual items of the framework (i.e., the MOOC Life Cycle, the Educational Design Pattern Language, and the related artifacts) as well as the framework as a whole. We used the participants' comments to evaluate the usefulness of the framework.

As summarized in Table 46, there were 11 participants involved in the pedagogical usability test to validate the LDF4MOOCs framework.

Table 46 - Learning designers profile – part I.

Experts	Experience in years	Expert field	Current main position	Spent time in min.
Expert A	2	Computer Science	e-Learning manager	102
Expert B	10	Mathematics	Professor – high school	180
Expert C	6	Pedagogy	Pedagogue	300
Expert D	27	Pedagogy	Professor – high school	180

Expert E	7	Languages	e-Learning manager	60
Expert F	6	Computer Science	Computer analyst	167
Expert G	10	Computer Science	Administrative assistant	210
Expert H	25	Languages	Learning designer	300
Expert I	15	Computer Science	Professor – higher education	137
Expert J	4	Computer Science	Learning designer	180
Expert K	2	Computer Science	Professor – technical school	120

Source: Elaborated by the author.

The time spent by each expert to create the map is on average 176 minutes with a median of 180 minutes.

Regarding the background questionnaire, two participants were learning designers in full-time (experts H and J) and nine were in part-time. Each participant had more than two-year experience in learning design (face-to-face or virtual). Their background was diversified, including participants with college degree in Computer Science (6), Mathematics (1), Pedagogy (2), and Languages (2). Five experts had a Master's degree: informatics and education (A, I, and J); education (D), and languages (E). One expert had a Ph.D. (G, in education) and two were doctoral candidates (A, in educational technology; I, in education).

The experts were also asked about: (i) their knowledge in designing virtual courses and MOOCs, (ii) understanding and using patterns and pattern languages, and (iii) the strategies and resources they commonly use to design for learning in any context. As we can verify by Table 47, the majority has more intermediate or advanced experience when designing virtual courses than MOOCs. Experts with background in Computer Science have larger general knowledge in patterns when compared to those with different academic basis. Lastly, when asked about the strategies or resources they use to design for learning, in any context, most of them do not use formal strategies or well-known artifacts. Among those who use artifacts, Learning Maps are the most common.

Table 47 - Learning designers profile – part II.

Experts	Design of virtual courses	Design of MOOCs	Knowledge on Patterns and Pattern Languages	Knowledge on learning design strategies and resources
Expert A	Intermediate	None	Intermediate	None
Expert B	Advanced	Intermediate	None	None
Expert C	Advanced	Intermediate	None	Storyboards and Learning Maps
Expert D	Advanced	Beginner	None	Learning Maps
Expert E	Advanced	Intermediate	None	Learning Maps
Expert F	Advanced	Beginner	Intermediate	ADDIE-based strategy, Bloom' Taxonomy, Learning Maps
Expert G	Intermediate	Intermediate	Intermediate	None
Expert H	Intermediate	None	Beginner	None
Expert I	Intermediate	None	Beginner	None
Expert J	Advanced	None	Intermediate	None
Expert K	Beginner	Beginner	Intermediate	Learning Maps

Source: Elaborated by the author.

Moving towards an analysis of the experts' answers for the pedagogical usability evaluation questionnaire, Table 48 presents the total of responses considering the five-point scale ranging from 1 (totally disagree) to 5 (totally agree). From a total of 132 observations, 78% were considered positive answers (i.e., agree or totally agree). The results also showed that the learning designers were positive about the framework, with learnability, effectiveness, and satisfaction being above average.

Table 48 - Distribution of answers.

Answer	Learnability	Effectiveness	Satisfaction	Total
Totally disagree	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Disagree	5 (22.72%)	7 (7.95%)	1 (4.54%)	13 (9.85%)
Neither agree nor disagree	1 (4.54%)	11 (12.50%)	3 (13.63%)	15 (11.36%)
Agree	14 (63.63%)	51 (57.95%)	15 (68.20%)	80 (60.61%)
Totally agree	2 (9.11%)	19 (21.60%)	3 (13.63%)	24 (18.18%)
TOTAL	22 (100%)	88 (100%)	22 (100%)	132 (100%)

Source: Elaborated by the author.

In order to examine concordance among the learning designers in their application of the framework to design MOOC Learning Maps, still regarding the pedagogical usability evaluation questionnaire, their level of agreement was firstly analyzed using the Fleiss' kappa (FLEISS, 1971, pp. 378–382). Fleiss' kappa is a generalized version of the statistic kappa (LANDIS; KOCH, 1977, pp. 159–174) to measure nominal scale agreement among more than two raters (e.g., learning design experts). In other words, it expresses the level of agreement between raters in a classification problem.

In general, the coefficient of agreement kappa ranges from -1 to +1, whereas a negative value indicates weak agreement, a positive value indicates greater concordance, and one positive indicates a perfect agreement between the raters. Furthermore, there is no consistent nomenclature when describing the relative strength of agreement associated with kappa statistic, but some studies, for example Landis and Koch (1977, p. 165), suggest the following ranges of kappa and the related labels (Table 49):

Table 49 - Interpretation of kappa.

kappa statistic	Strength of Agreement
<0.00	poor
0.00 - 0.20	slight
0.21 - 0.40	fair
0.41 - 0.60	moderate
0.61 - 0.80	substantial
0.81 - 1.00	almost perfect

Source: (LANDIS; KOCH, 1977, p. 165).

According to tables 49 and 50, general agreement among the learning design experts was fair with Fleiss' kappa of 0.3435. Regarding each category (i.e., learnability, effectiveness, and satisfaction), their agreement ranges from moderate (effectiveness) to substantial (learnability and satisfaction). As we can see, there is agreement among the experts, but at different levels for each category.

Table 50 - Fleiss' kappa results.

Category	Kappa statistic	Interpretation
learnability	0.6589	substantial
effectiveness	0.4930	moderate
satisfaction	0.6333	substantial
General	0.3435	fair

Source: Elaborated by the author.

Kendall's coefficient of concordance (Kendall's W) (KENDALL; SMITH, 1939) can be used in association to kappa statistic. Kappa statistic considers an absolute agreement between classifications, whereas Kendall's coefficient measures the association between them. It means that Kendall's W does not treat all the wrong classifications equally, as kappa statistic does. For example, if Expert A assigns 'Strongly Agree' to a question *x*, Expert 2 assigns 'Agree', and Expert 3 assigns 'Strongly Disagree' to the same question, Kendall's W considers that Expert A is in more disagreement with Expert C than with Expert B. As shown in (CAFISO; DI GRAZIANO; PAPPALARDO, 2013, p. 4), a high or significant value of Kendall's W coefficient may be interpreted as meaning that the raters are applying essentially the same standard in ranking the questions under study. In other words, if W = 0, there is no agreement among the raters; if W = 1, then the raters are unanimous in their opinion. Intermediate values of W indicate lesser or greater degrees of agreement. Table 51 shows the guidelines for the interpretation of Kendall's W, according to Cafiso, Di Graziano and Pappalardo (2013, p. 4).

Table 51 - Interpretation of Kendall's W.

W	Interpretation
$W \leq 0.3$	Weak agreement
$0.3 < W \leq 0.5$	Moderate
$0.5 < W \leq 0.7$	Good agreement
$W > 0.7$	Strong agreement

Source: (CAFISO; DI GRAZIANO; PAPPALARDO, 2013, p. 4).

Thus, Kendall's W coefficient of agreement was used to re-examine consistency among the 11 learning designers. The results (Table 52) indicated strong agreement on learnability (W 0.8956), and satisfaction (W 0.9379), and good agreement on effectiveness (W 0.6119).

Table 52 - Kendall's W results.

Category	Kendall W	Interpretation
learnability	0.8956	Strong agreement
effectiveness	0.6119	Good agreement
satisfaction	0.9379	Strong agreement
General	0.5255	Good agreement

Source: Elaborated by the author.

As we previously said, the learning designers had the opportunity to write free texts and justify their answers for each category (i.e., learnability, effectiveness, and satisfaction). Furthermore, they also had chance to write their impressions about the individual items of the framework (i.e., the MOOC Life Cycle, the Educational Design Pattern Language, and the related artifacts) as well as the framework as a whole. By exploring the comments and suggestions for improvement, we identified that (Table 53):

Table 53 - Kendall's W results.

Expert	Comment
Expert G	Suggested that a well-detailed model of and the use of the framework in real contexts should be provided for the users interested in using the framework (i.e., a complete and real example), whereas Expert F suggested the inclusion of examples of success cases.
Expert A	Argues that the framework provides guidance for teachers, support for improving the design of teaching in such context, opportunity for documenting and sharing MOOC learning designs, as well as advice on the use of the framework to obtain pedagogical-evaluative insights into the MOOC development process. However, once teachers have a framework-based Learning Map, how give them feedback and evaluation support on the pedagogy in the learning design they developed? In other words, if MOOC learning designs are developed through the framework, how teachers can be sure about their adherence to the design concepts provided in the framework? Such topic, which is related to the evaluation of learning designs through formal representation, was approached by (LAURILLARD; LJUBOJEVIC, 2011; LAURILLARD, 2013), but still is a topic to be further investigated by the community. In this thesis, such gap is considered a future work.
Expert D	Considers the patterns title definition a challenge and suggests the use of more intuitive names.
Expert E	Suggests the use of icons in the patterns description in order to improve their categories' identification.
Expert X	Considers the Educational Design Pattern Language the most difficult item of the framework, which may require a detailed reading and analysis in its first use, whereas Expert J suggest the improvement of the pattern language presentation in order to increase its understanding.

Source: Elaborated by the author.

Based on the results of the pedagogical usability evaluation, the initial presentation of the framework (i.e., guidance to initial steps) was modified; new patterns were included; some of them were rewritten (context and title, mainly); the graphical elements of the MOOC Life Cycle were also adapted to a friendlier and illustrated version; to conclude, new examples explaining how to use the framework were also considered.

6.4 Field Evaluation

As a way to increase external validity (HARRISON; LIST, 2004), a field evaluation was performed to verify the effect of the use of the framework in real learning design settings. Thus, human subjects (i.e., teachers, learning designers) were allowed to perform regular learning design tasks (i.e., creating a Learning Map) from their real places of work (i.e., at school or at home), wherever and whenever was more convenient to them, to design a MOOC Learning Map considering their own needs or contexts. The artificial elements in this evaluation were: (i) the fact that the participants had to access the framework by an open, online, and experimental[83] course; (ii) they were informed that they were taking part in a field evaluation; and (iii) related data (i.e., Learning Maps, video scripts, pre and post questionnaires) were recorded and analyzed.

6.4.1 Design

The field evaluation was driven by the following research questions (i) *Can the LDF4MOOCs framework be used by instructors as a guide to design MOOCs?*, and (ii) *Are the Learning Maps created by instructors who used the framework as a guide more adherent to the desirable characteristics for MOOCs than projects created using ad hoc decisions?*

The field evaluation was divided into eight steps:

(1) an experimental MOOC named *Creating Learning Projects for MOOCs* was delivered on the Tim Tec platform, as previously described in Section 6.2.

(2) an invitation to attend the course was sent to all users registered in the MOOC platform; people from other institutions were also invited through e-mail; and news were posted on the IFSULDEMINAS main website[84];

(3) the participants enrolled in the course were asked to complete a background questionnaire;

[83] In this case, the related course was called experimental since we used some strategies not adequate for online and massive courses, such as individual and manual verification of the products delivered by the participants.
[84] https://www.ifsuldeminas.edu.br/index.php/noticias/1442-curso-mooc

(4) the participants had two weeks to outline their MOOC projects using their own knowledge (i.e., on an ad hoc basis);

(5) the participants used the *Instrument to Support the Evaluation of Learning Maps in the MOOC Context* (Appendix C) to self-evaluate the outline;

(6) the participants were asked to understand and use the LDF4MOOCs framework and its elements, and develop a Learning Map using a specific template (i.e., a Learning Map). They had two weeks to perform this task;

(7) the participants used the same artifact also applied in the step (5) to self-evaluate their Learning Maps;

(8) to conclude, they were asked to complete an evaluation questionnaire.

6.4.2 Materials and instruments

The course related to this field evaluation is available at https://mooc.ifsuldeminas.edu.br/course/projeto-de-aprendizagem-para-moocs/intro/.

In turn, the evaluation questionnaire[85] items were mainly developed to verify how much the framework was useful to design MOOCs by considering the viewpoint of real people interested in the development of such type of virtual course. We verified ease of use of the framework; satisfaction in using it; confidence in using it; intention of future use; as well as the impact of developing a MOOC Learning Map through the framework. Open-ended questions were also used to collect weak points of the framework that need more clarification.

6.4.3 Participants

The course related to the field evaluation took place from July 2017 to September 2017. The course was open to everyone, but the target audience in its design was educators, learning designers, tutors, and others interested in learning more about MOOCs and deliver courses in this format. Entry to the course was completely free.

Overall, at that time, about 160 people registered for the Creating Learning Projects for MOOCs. 15 students (≅9.5%) fulfilled all the requirements to conclude the course: watch at least 70% of videos; create the MOOC Project Outline (using ad hoc approach); self-evaluate the outline using the given artifact; create a MOOC Learning Map using the LDF4MOOCs framework; self-evaluate the Learning Map using the same given artifact; attend a pair-

[85] A full version of the evaluation questionnaire is available at https://goo.gl/forms/hBz1iI5VH8JgQe9M2.

evaluation and insert comments on the maps shared by the colleagues; create and share related video scripts (at least two video scripts). After finishing the requirements, the concluding participants were able to get a free and digital certificate issued by the IFSULDEMINAS.

The data analyzed for the field evaluation considered those 15 participants and the two artifacts created by each one (i.e., one from the use of an ad hoc basis and the other one from the use of the LDF4MOOCs framework). The sample population included heterogeneous genders, age groups, educational degrees, qualification areas, and geographic location. Table 54 summarizes the background of the 15 participants of the field evaluation.

Table 54 - Participants of the field evaluation.

Gender		Age				Highest degree			
Female	Male	20-31	31-40	41-50	51-60	University	Specialization	Master	Ph.D.
3 (20%)	12 (80%)	2 (13%)	5 (33%)	4 (27%)	4 (27%)	2 (13%)	3 (20%)	4 (27%)	6 (40%)

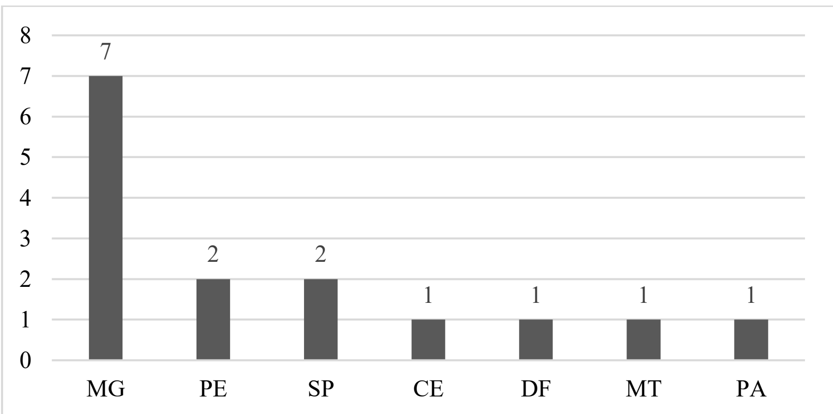
Source: Elaborated by the author.

Considering their degrees, the main areas of qualification are:

- Exact and Earth Sciences: 7 participants (47%);
- Linguistics, Literature and Arts: 4 participants (27%);
- Humanities and Social Sciences: 3 participants (20%);
- and Health Sciences: 1 participant (6%).

Figure 48 highlights a variety of geographic location of the participants, considering their state of origin in Brazil.

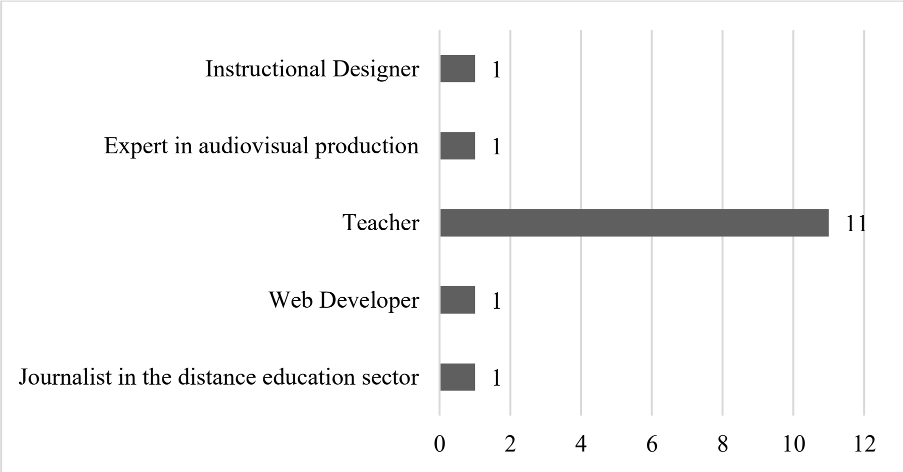
Figure 48 - Distribution of the participants’ state of origin.



Source: Elaborated by the author.

In addition to the previous characteristics, Figure 49 presents the distribution of the participants considering their main job or professional activity.

Figure 49 - Distribution of the participants' main job.



Source: Elaborated by the author.

With respect to their knowledge on MOOCs and design of virtual courses, only four participants had advanced experience in designing virtual formal courses. About 11 (73%) participants defined themselves as novices in the task of designing MOOCs, and four (27%) declared themselves with intermediate knowledge to develop this type of course.

6.4.4 Data Collection and Analysis

To answer the first research question previously defined (*Can the LDF4MOOCs framework be used by instructors as a guide to design MOOCs?*), the data collected from the evaluation questionnaire were analyzed and the main findings are described following.

Ease of Use. In general, people interested in using the framework will have more contact with the Pattern Language. Thus, we first tried to understand how the PL was used by the subjects attending the field evaluation. In general, four subjects (≈27%) used the PL almost entirely; 11 subjects (≈73%) followed the PL in a partial way, which means that some patterns or information within them were not strictly followed or in the suggested order. When asked about the main reason to not follow the PL in a more complete way, the main answer was poor time management.

Table 55 presents other findings concerning the use of the framework and its elements.

Table 55 - Results from the evaluation questionnaire about the use of the Framework.
(TD – Totally Disagree, D – Disagree, N – Neither Agree nor Disagree, A – Agree, TA – Totally Agree).

Sentences	Answers				
-	TD	D	N	A	TA
The use of LDF4MOOCs was a productive experience ("I did a lot in a short time").	-	-	5	8	2
The use of LDF4MOOCs improved my knowledge about the development and learning design for MOOCs.	-	2	2	7	4
The use of the PL is a waste of time.	6	5	3	1	
The PL is easy to use.	-	2	4	8	1

Source: Elaborated by the author.

Satisfaction. The participants were asked about their level of satisfaction when using the framework to design their MOOC Learning Maps, as summarized by Table 56.

Table 56 - Results from the evaluation questionnaire about the satisfaction when using the framework.
(VU – Very Unsatisfied, U – Unsatisfied, N – Neither Satisfied nor Unsatisfied, S – Satisfied, VS – Very Satisfied).

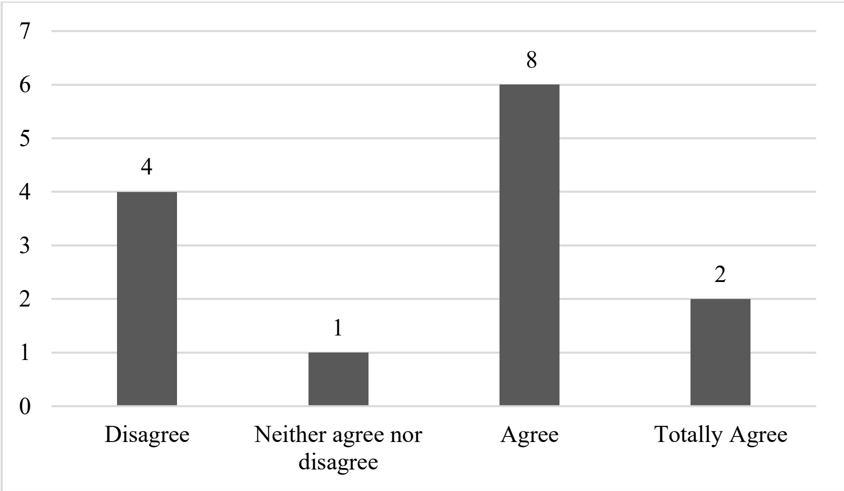
Sentences	Answers				
-	VU	U	N	S	VS
How satisfied were you when using the Pattern Language to develop your MOOC Learning Map?	-	1	3	9	2
How satisfied were you with the final result of your MOOC Learning Map developed through the use of the Pattern Language?	-	2	2	10	1

Source: Elaborated by the author.

Confidence. The participants were also asked about their level of confidence when using the LDF4MOOCs framework.

Figure 50 presents the distribution of answers related to the sentence *Comparing the creation of the MOOC Project outline (ad hoc) and the MOOC Learning Map (using LDF4MOOCs), my level of confidence in developing MOOCs increased when I used the framework as support*.

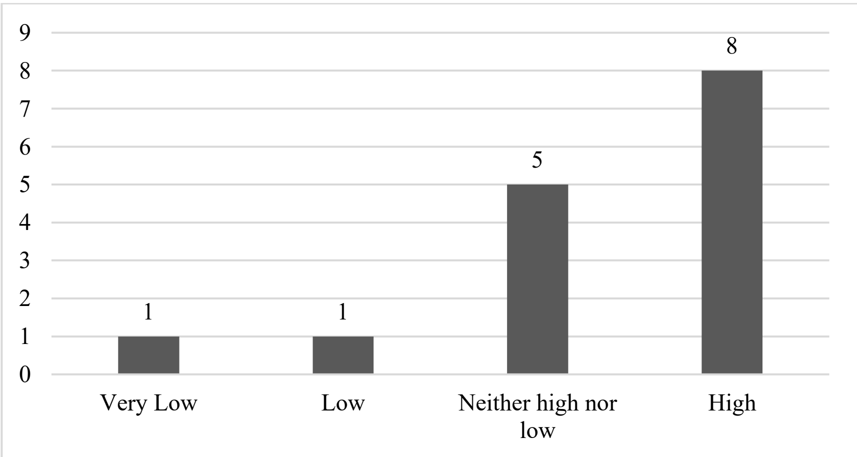
Figure 50 - Distribution related to the increase of confidence when using LDF4MOOCs.



Source: Elaborated by the author.

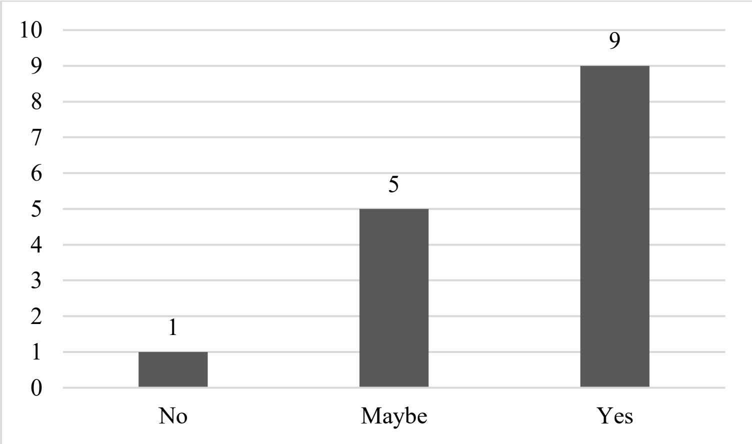
Figure 51 summarizes the results related to the sentence *How do you evaluate your level of confidence in developing the Learning Map for your MOOC using the framework?*

Figure 51 - “How do you evaluate your level of confidence in developing the Learning Map for your MOOC using the framework?”.



Intention of future use. According to Figure 52, in general, the participants of the field evaluation had high beliefs about future use of the LDF4MOOCs framework to design new MOOC projects. The subject who said “no” declared to be more adept of formal and virtual courses which follow more predefined structures. People who scored “maybe” said they need to study further about MOOCs and the framework needs a tool to support its use by everyone. People who said “yes” consider the framework and mainly the Pattern Language as an adequate way to organize thinking and support reasoning.

Figure 52 - “Would you use the framework for the development of future MOOC projects?”.



Impressions from the participants to improve LDF4MOOCs. The LDF4MOOCs framework and mainly the Pattern Language were modified based on the previous data analysis. Additional comments and suggestions from the participants, using open questions, were also used to improve the patterns, including:

- insertion of more illustrative examples and additional links to materials;
- development of a tool to guide the use of the Pattern Language;
- proposition of templates that provide a set of patterns to support specific questions and needs that a user may have (i.e., if a user wants to create a MOOC based on Project-based Learning, thus only a set of related patterns should appear to him/her).

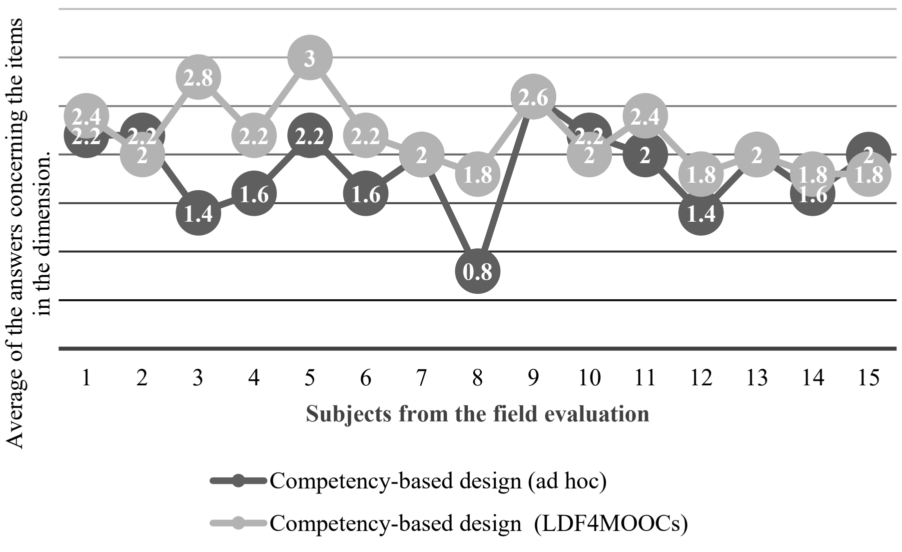
To answer the second research question (*Are the Learning Maps created by instructors who used the Framework as a guide more adherent to the desirable characteristics for MOOCs than projects created using ad hoc decisions?*), we considered the answers related to the self-evaluation of the MOOC Project Outline (created using an ad hoc strategy) and the answers from the self-evaluation of the MOOC Learning Map (developed using the framework) both through the use of the *Instrument to Support the Evaluation of Learning Maps in the MOOC Context* (Appendix C), as described previously. In addition, an exploratory study was performed by specialists, in order to analyze and compare the project outline and the Learning Map in a qualitative way. The main results are presented following.

Self-evaluation of the MOOC project outline (created using an ad hoc strategy) versus Self-evaluation of the MOOC Learning Map (developed using LDF4MOOCs).

The instrument used to evaluate the Project Outlines and Leaning Maps in the field evaluation had a total of eight dimensions of desirable characteristics for MOOCs. Each dimension contains several related items. The subjects had to check to what extent their Maps contemplated such items. In Figure 53, we focus on “Competency-based design”, which contains five items, and analyze the Learning Maps of 15 subjects. The balls represent the average of answers concerning the five items of this dimension, for each subject, based on a four-point Likert Scale ([0] Not contemplated; [0.1 – 1.0] Partially contemplated; [1.1 – 2.0] Sufficiently contemplated; [2.1 – 3.0] Totally contemplated).

In general, the average of values belonging to Learning Maps developed with the PL support is higher than maps created using the ad hoc approach. This trend was observed in other dimensions, such as “User-centered Learning” and “Self-Regulation Learning”.

Figure 53 - A sample of fifteen subjects and the average of their MOOC Learning Projects evaluation using ad hoc versus the LDF4MOOCs framework.



Source: Elaborated by the author. Adapted from (GOODYEAR et al., 2004)

Exploratory Study. We also conducted an exploratory study to qualitatively examine and compare the structure and the learning design components used to create both the projects (i.e., either using an ad hoc basis or the proposed LDF4MOOCs). Firstly, we collected all the learning design items used by the participants, either using ad hoc basis or the framework. The items are synthesized in Table 57, but considering the number of times they were used in each strategy.

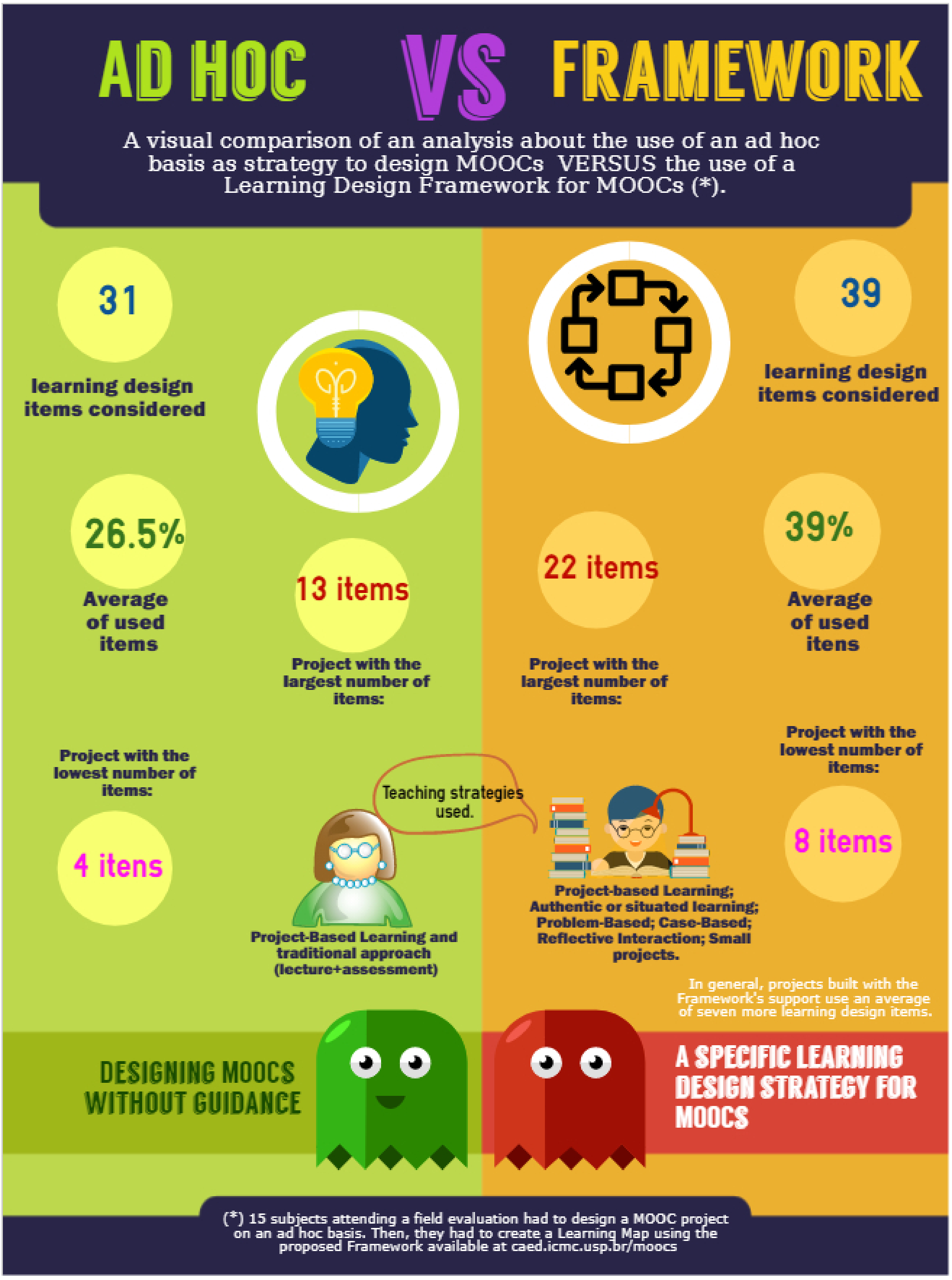
Table 57 - Items and the number of times each one was used in each strategy.

Groups	Learning Design items	Ad hoc	LDF4MOOCs
Context	MOOC name (title)	11	**14**
	Motivation to deliver the MOOC	2	0
	MOOC Team	4	**14**
	Target public	1	1
	General content	10	**14**
	Duration (in weeks or hours)	1	1
	MOOC Platform or provider	2	**14**
	Guidance to use the platform	0	**2**
	Pre-Requirements	3	**14**
	MOOC main goal	10	**14**
	MOOC' specific goals	1	1
Curriculum Elements	MOOC's Overview	0	**4**
	Being a student in a MOOC	0	**1**
	Syllabus	9	**12**
	Learning outcomes	1	**12**
	Student's profile characterization	0	**2**
	Teaching Strategy	7	**15**
Support	Tutoring	1	0
	Email	1	1
Teaching and Learning Materials and strategies	Video	11	**14**
	Web Forms	1	0
	Text	6	**7**
	Forum	6	**7**
	Shared directory	1	1
	Web Research	1	0
	Supplementary material	3	**5**
	Models/Examples	2	**5**
	Theoretical Exercises	6	1
	Practical Exercises	0	**4**
	Content Production	5	4
	Facebook	1	0
Collaboration	Discussion in pair	2	1
	Chat	1	0
Adjacent platform	Quiz	0	1
	Different Adjacent platforms (e.g. BBC website, Duolingo)	0	**3**
Formative and Summative Assessment	Initial Self-evaluation	0	**2**
	Final Self-evaluation	2	**6**
	Continuous Self-evaluation	0	**2**
	Final Test	3	**4**
	Support to self-regulation learning	0	**1**
	Initial question	0	**3**
	Recovering the initial question during the course	0	**2**
	Exercise correction (demonstration of solutions)	0	**1**
	Pair evaluation	1	1
Evaluation	Course evaluation	0	**3**

Source: Elaborated by the author.

From this analysis, an infographic (i.e., an information graphic) was derived. Figure 54 presents a summarized and visual strategy to understand the differences between using an ad hoc basis or using the proposed framework to design MOOCs.

Figure 54 – Infographic: visual comparison of using ad hoc versus LDF4MOOCs to design MOOCs.



Source: Elaborated by the author.

6.4.5 Interpretation and Results from the Field Evaluation

The field evaluation as an external evaluation method yielded interesting findings and insights and assisted us in improving the LDF4MOOCs framework organization and mainly the Pattern Language description.

Considering the first question that guided the field evaluation design, *Can the LDF4MOOCs framework be used by instructors as a guide to design MOOCs?*, the data analysis indicates that instructors, educators, learning designer practitioners, among others, obtained better results when using the framework; the framework can assist them mainly during the design of MOOCs, but also in the other phases (e.g. development and delivery). Around 53% agreed about the easiness of use of the framework; 67% declared themselves satisfied about using the framework to design their MOOC Learning Maps; 53% agreed that their level of confidence in developing MOOCs increased when they used the framework as a guidance strategy; and 60% intend to use the framework in the future.

Concerning the second research question, *Are the Learning Maps created by instructors who used the framework as a guide more adherent to the desirable characteristics for MOOCs than projects created using ad hoc decisions?*, the emerged data also suggest that instructors developing MOOC Learning Maps get better results when having the guidance of the framework than using ad hoc approach. In general, the average of values belonging to Learning Maps developed with the support of the framework is higher than maps created using ad hoc approach, as summarized in Figure 53. This trend was observed in other dimensions, such as "User-centered Learning" and "Self-Regulation Learning". The number of elements considered during the MOOC design is also higher when using the framework as a support (Table 57 and Figure 54). Thus, there is evidence that Learning Maps developed using the LDF4MOOCs framework contemplate more desired characteristics for MOOCs and learning design elements than those based on ad hoc or random decisions.

6.4.6 Limitations and Threats to Validity

We consider some facts that may affect and impact the analysis and interpretation of the results from the field evaluation. The main threats to validity of the field evaluation are presented in two categories.

Internal Validity. It is concerned with the validity within the given environment and the reliability of the results. An issue to be considered is that the use of the framework as a support was compared to a different approach. However, the comparison was with respect to an ad hoc approach since this is still a common practice between practitioners (i.e., they still tend to design MOOCs by their own, as described in the Exploratory Survey presented in Section 3.2). A different strategy from the ad hoc method was not considered because we were not able to identify an appropriate, well-established and specific approach for the MOOC context in order to compare our framework with. Despite that, additional studies are needed to examine and compare the effects of using the framework and other specific and well-validated strategies to design for learning in the MOOC context.

External Validity. It is concerned to how general the findings are. There is a risk that the sample is not representative of the population. In fact, only Brazilian participants attended the field evaluation and people from other countries were not considered yet. However, it was mitigated by applying the background questionnaire and inviting representative people, such as educators, learning designers, tutors, and other subjects interested in learning more about MOOCs and deliver courses in this format. Furthermore, all of them had similar level of experience in designing MOOCs, i.e., they were novice MOOC instructors, creating their first course in this context.

Some facts may also have affected the analysis and interpretation of the results obtained from the field evaluation since the participants had their first access to the framework by having a related open, virtual and experimental course as a guide. Isolate this variable, i.e., the way they had access to the framework, is not simple. Thus, further research is needed to investigate the effects of practitioners using the framework without any complementary guidance.

6.5 SUMMARY

This chapter presented the main strategies used in the evaluation process of the LDF4MOOCs framework and its elements in order to revise, refine, and improve them. In fact, we focused on the use of formative approaches, in order to strengthen the relationship between research and action in a cooperative and participative way, always trying to integrate the related subjects (i.e., teachers, students, learning designers, academic institutions and researchers). Such emphasis was needed since this doctoral work was guided by the interventionist nature of the Educational Design Research (EDR), as highlighted in Section 1.2.

The evaluation process of the LDF4MOOCs framework also differs from other approaches that have been developed to support MOOC design. In Section 3.1, for instance, we summarized some related approaches and highlighted their construction and validation models. It was possible to identify a lack of further investigation on the construction and validation strategies of the analyzed approaches. On the other hand, as presented previously, our framework and its main elements were validated by an iterative process using different methods to investigate the effects of using LDF4MOOCs under different stakeholders' viewpoint.

In the experimental study, Wilcoxon signed rank tests were employed to illustrate whether there were any differences between using ad hoc and LDF4MOOCs approaches in terms of adherence of the produced Learning Maps to the desirable characteristics for MOOCs. Considering all dimensions together, i.e., the global adherence of the produced Learning Maps to the desirable characteristics for MOOCs specified in the rubric used by the participants, there was a significant difference between the maps built on an ad hoc basis and those guided by the LDF4MOOCs. LDF4MOOCs-based maps had a higher average score for adherence to the desirable characteristics for MOOCs than those developed by using an ad hoc basis.

The case studies, in turn, provided a deeper understanding about the MOOCs development process. They also acted as formative evaluation of the LDF4MOOCs framework and increased our understanding on the use of the framework in real contexts. Five courses were created and described: three of them related to Software Engineering Education (SEE); one meta-MOOC; and one experimental and meta-learning design MOOC. Case studies related to SEE were also an opportunity to explore teaching and learning in software engineering-based MOOCs and how they could be better pedagogically designed. The learning design decisions made for each case study as well as the data collected from platforms and surveys suggest that using LDF4MOOCs can have a positive impact on the design for learning in MOOCs.

Beyond the experimental study and the case studies, two types of expert reviews were also performed as internal validation methods. One with patterns specialists who focused on the patterns content and the pattern language structure, and one with learning designers who explored pedagogical aspects of the framework by considering learnability, effectiveness and user satisfaction. Furthermore, the items of the framework were modified and supplemented by considering the experience and practical perspectives of the patterns experts and learning designers. In the experts review with learning designers, the Fleiss' Kappa and the Kendall tests of concordance were shown to be useful tools for verifying the consensus among the participating experts. Both reviews showed preliminary evidences that the framework can be effectively applied to the design of MOOCs.

Lastly, this chapter described a field evaluation used as an external validation method to confirm the feasibility of LDF4MOOCs. The field evaluation provided more meaningful information about the use of the framework in natural settings than in a laboratory setting.

Nevertheless, despite the use of an extensive process of reviewing and validating the framework with end users, patterns experts, and learning designers, there were some limitations. For example, participants from other countries were not considered in the experimental study, in the learning designers review and in the field evaluation. Taking into account the openness characteristic of MOOCs, a broader diversity and number of human subjects from everywhere should be recruited to voluntary evaluate the framework and its main elements, and to determine if same results can be obtained in different cultures and geographical specificities. In addition, the framework was mainly tested for its effects on MOOC learning design. Thus, further research is needed to examine the framework-based MOOCs' effectiveness on students learning outcomes.

In the next chapter, we close the research by summarizing the main contributions and presenting the main perspectives for continuing this work.

7 CONCLUSIONS AND FUTURE WORK

In this chapter, we present an overview of the research conducted, its main contributions and limitations, perspectives for future work and resulting publications.

7.1 OVERVIEW

MOOCs are an instance of the open and online education movement and over the last years they have promoted a lot of discussion among the educational and technology communities (CONOLE, 2014a; MARGARYAN; BIANCO; LITTLEJOHN, 2015). Still nowadays there does not exist a definition for MOOCs that is broadly accepted. For example, the Commonwealth of Learning, through (PORTER; BEALE, 2015), defines a MOOC as an online course that generally requires no prior qualifications for entry, can be accessed by anyone who has an Internet connection, and includes large or very large numbers of learners. In a very similar context, Brouns et al. (2014) define them as online courses designed for a large number of participants that can be accessed by anyone and anywhere, as long as they have an internet connection; they are open to everyone without entry qualifications and offers a complete course experience online for free.

The creation and adoption of MOOCs can bring many benefits and impact on education, such as put forward diversity in education; enhance student's learning by encouraging and engaging them for lifelong learning; connect with more individuals in informal contexts creating opportunities to transition to formal higher education or lifelong learning activities; force a re-conceptualization of higher education through the use of online study; enhance teachers' skills from developing Open Educational Resources (OERs) and adopting learner-centered pedagogical approaches and active learning strategies; among others (SCHOPHUIZEN et al., 2018).

Despite the potential of MOOCs, there still are challenges and open issues that require further investigation. The design of innovative and groundbreaking MOOCs has been a difficult task for practitioners, especially novices, because there is no definite standard about the desirable design characteristics of MOOCs. As a consequence, many teachers have to face the challenge of creating educational content to be offered in MOOCs from scratch (KLOOS et al., 2016). In addition, most of the existing MOOCs are still based on traditional classroom formats, such as teacher-centered approaches and content-based learning, which are less effective as a means of learning in the MOOC context (FASSBINDER; DELAMARO; BARBOSA, 2014).

Therefore, as highlighted in (ZHU; SARI; LEE, 2018), it is necessary to more actively target MOOC instructors and learning designers as well as inquire more deeply into decisions related to the entire MOOC development process and pedagogical issues.

Thus, the design and development of MOOCs require the use of appropriate mechanisms and systematic procedures to ensure the standardization and the productivity of all the aspects involved in the MOOC development process, and to meet the desired quality of the resultant materials. To this end, in this work we proposed a Learning Design Framework for MOOCs, named LDF4MOOCs. LDF4MOOCs can be used by practitioners and technologists when studying, designing MOOCs or developing mechanisms related to them (e.g., virtual learning environments, learning design tools). LDF4MOOCs builds on Software Engineering methods and practices to support the design for learning in the context of MOOCs.

LDF4MOOCs consists of: (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 supporting resources (artifacts and digital tools). In addition, LDF4MOOCs is pedagogically informed by Flipped Learning ideas and fundamentals, which act as an effective intervention to support learning in MOOCs, helping learners to take the active role in their own acquisition process of skills and knowledge construction.

Educational Design Research (ANDERSON; SHATTUCK, 2012; MCKENNEY; REEVES, 2012; NIEVEEN, 2009) was chosen to guide this study. In order to evaluate the LDF4MOOCs and its elements, we conducted one experimental study, five case studies, and experts review with patterns and learning design specialists as internal evaluation methods. Furthermore, a field evaluation with educators using the framework to design MOOCs was considered as an external evaluation method. Although preliminary, the results obtained from the evaluation methods have provided positive feedback regarding the applicability and effectiveness of the LDF4MOOCs framework to support the development of MOOCs.

7.2 CONTRIBUTIONS

The main contributions of this Ph.D. research are the following:

- **Characterization of the state-of-the-art on MOOCs**. An evidence-based research consisting of a systematic mapping identification was used to identify and aggregate concepts, historical facts and development path, principles, types, and supporting web environments related to MOOCs.

- **Characterization of the state-of-the-art on existing learning design strategies for MOOCs**. A concise landscape on the design and development of MOOCs in the global scenario, with a focus on strategies to design for learning in this context, was explored through a literature review and a survey-based research. The aim was to investigate them and to find gaps as well as links or common characteristics under the view of learning designers and educational technologists.
- **Proposition of desirable characteristics for MOOC Learning Maps.** Considering the previous contributions, an *Instrument to Support the Evaluation of Learning Maps in the MOOC Context* (Appendix C) was defined to assist MOOC teams, mainly instructors and learning designers, when verifying the quality of a project and its adherence to the characteristics desirable for MOOCs. It can also guide the development of new functionalities for MOOC platforms to support self-regulation learning, social networking and collaborative learning, new ways of assessment, among other characteristics.
- **Design and building of a MOOC Life Cycle.** The conceptual and visual model represents the main steps from an initial idea or need to the delivery of a MOOC and its evaluation phase. It provides a comprehensive structure for systematically create MOOCs.
- **Establishment and evaluation of an Educational Design Pattern Language for MOOCs.** While the MOOC Life Cycle provides a top-level overview of the phases and activities regarded to the MOOC development (i.e., “what-to-do” items), the proposed patterns-based approach establishes a way of “how-to-do” and congregates practical aspects to enhance the design for learning. The 49 patterns are grouped into eight categories and they represent practitioners’ experiences. In addition to encourage sharing knowledge, the pattern language also gives each person who uses it, the power to create a variety of new learning designs.
- **Proposition of LDF4MOOCs.** The main contribution of this work is the proposition of a Learning Design Framework for MOOCs. The LDF4MOOCs framework aims to support practitioners and technologists when investigating, designing or developing MOOCs. LDF4MOOCs consists of: (i) a MOOC Life

Cycle; (ii) an Educational Design Pattern Language for MOOCs; and (iii) related supporting resources.

- **Instantiation of LDF4MOOCs to develop Software Engineering-related MOOCs.** To validate and improve the proposed framework, three MOOCs related to the Software Engineering area were delivered: (i) Agile Software Development; (ii) Web Development with Agile Practices, and (iii) Introduction to Software Testing. This leads us to explore the main practices and challenges when designing MOOCs in the context of Software Engineering. In addition, new methods and strategies to support lifelong learning in Software Engineering through open and online courses were also investigated.
- **Development of Open Educational Resources for Software Engineering Education.** To support the delivered MOOCs, several Open Educational Resources were developed, such as videos, figures, cases, reports, among others.
- **Artifacts and Tools to support learning design with LDF4MOOCs.** The need to improve the quality of MOOCs has fostered the development of web tools and artifacts to support effective design for teaching and learning in this context. In this work**,** we proposed a template of learning maps for MOOCs; an *Instrument to Support the Evaluation of Learning Maps in the MOOC Context* (Appendix C); and the framework's website.

7.3 LIMITATIONS AND FUTURE WORK

The main limitations related to the work undertaken in this Ph.D. research are summarized as follows:

- **Target audience**. As described in Chapter 5, the LDF4MOOCs framework main focus is small MOOC teams and even single teachers with limited financial, technological and human resources. We also had the concern of drawing the framework having novice MOOC practitioners in mind. We believe that larger teams, with well-defined roles, as well as experienced practitioners could be able to use the framework without major problems. However, this issue was not investigated in this work and deserves future investigation.
- **Patterns of Active Learning Strategies**. The case studies conducted, i.e., the MOOCs developed, are focused on the Project, Case, and Problem-based learning strategies. MOOCs using other approaches, for instance Educational Role-

Playing, Team-based Learning, among others, were underexplored. Patterns related to them were mainly collected from literature review, but new MOOCs can be designed under their support.

- **Case Studies**. The MOOCs delivered are available only in Portuguese, and this can be a limitation considering the "openness" characteristic behind the concept of MOOCs. Furthermore, only three MOOC platforms (Tim Tec, MiríadaX and Coursera) were used to deliver courses, and their pedagogical and technological limitations may have influenced on part of the results obtained from the case studies.
- **Experimental Study**. Only one experimental study was conducted and involved a small number of participants, what may affect the representativeness of the sample of population.
- **Experts Review (Learning Designers)**. One experts review with 11 learning designers was conducted, but we only considered the Brazilian context. An international review should be conducted in order to improve the results generalization.
- **Field evaluation.** A field evaluation with 15 practitioners was conducted but still considering only the Brazilian public. Furthermore, the majority of the Learning Maps developed by the practitioners using the LDF4MOOCs framework as a support were not turned into MOOCs to be delivered due to the participants' time restrictions.
- **Learning Analytics.** Evaluation methods were used to deeper understand LDF4MOOCs application as well as evaluate and refine the framework. We were also interested in investigating the effects of using the framework, its elements, the resulting MOOCs, and the impact of such elements and products on users, such as learners, instructors, and learning designers. However, further research is needed to examine the effectiveness of the framework-based MOOCs on students learning outcomes. We only performed basic analysis on students' comments and interaction with the used MOOC platforms. Advanced techniques of Learning Analytics, for instance, could be applied to obtain perceptions that can be used to improve students' success in the course.

We can identify several possibilities of continuity of the work undertaken in this Ph.D. thesis and future directions for research. Following we briefly summarize some of them:

- **Further validation.** More experiments to validate the LDF4MOOCs framework are needed. Thus, through longer and more thorough investigations, we intend to better identify the contributions originated by the use of the framework, especially regarding learning outcomes effectiveness.
- **New patterns and pattern languages.** The Educational Design Pattern Language can be extended to support additional aspects related to the development of Open Educational Resources as well as new kinds of active learning strategies and assessments.
- **Development of a software to support the use of the framework.** During the field evaluation and the experts review with learning designers, we identified that the development of a tool to support the use of the framework by practitioners would benefit its application agility.
- **From the MOOC design research to guidelines for the development of MOOC platforms.** The current MOOC platforms still do not provide functionalities to support the creation of courses based on different types of active learning strategies (e.g., Team-based learning, Educational Role-Playing, Project-based Learning, among others). Furthermore, (FIDALGO-BLANCO; SEIN-ECHALUCE; GARCÍA-PEÑALVO, 2016) argues that is difficulty to manage flows of knowledge in MOOC models based on cooperative learning because the current MOOC platforms do not facilitate the organization of resources cooperatively generated by participants. In addition, according to Staubitz et al. (2016), peer grading in virtual leaning platforms does not always deliver accurate results compared to human experts. In a previous study, we identified an initial set of pedagogical requirements that can be used to define, analyze, improve and compare MOOCs platforms (FASSBINDER; FASSBINDER; BARBOSA, 2016). Thus, future research must focus on how better use knowledge from MOOC design research to improve the development of platforms and providers.

7.4 RESULTING PUBLICATIONS

The main publications resulting from the activities conducted during this Ph.D. research are summarized as follows (Table 58).

Table 58 - Main publications.

Seq	Year	Main subject	Reference
1	2018	LDF4MOOCs and Web Development Education-based MOOCs	FASSBINDER, A. G. O.; FASSBINDER, M. and BARBOSA, E. F. **Massive Open Online Courses on Web Development Education: A Case Study**. In: 48th IEEE Frontiers in Education (FIE) Conference. San Jose, California, USA, 2018.
2	2017	Educational Design Pattern Language	FASSBINDER, A. G. O.; MAGOULAS, G. and BARBOSA, E. F. **Developing an Educational Design Pattern Language for MOOCs**. In: XXVIII Simpósio Brasileiro de Informática na Educação (SBIE). Pernambuco, Brasil, 2017.
3	2017	Self-regulated learning in MOOCs	FASSBINDER, A. G. O. e BARBOSA, E. F. **Estudo e Aplicação da técnica Learning Mosaic no apoio à autorregulação da aprendizagem em Cursos Abertos Online e Massivos (MOOCs)**. In: XXIII Workshop de Informática na Escola (WIE), Pernambuco, Brasil, 2017.
4	2017	Educational Design Pattern Language	FASSBINDER, A. G. O.; MAGOULAS, G. and BARBOSA, E. F. **Towards an Educational Design Pattern Language for Massive Open Online Courses (MOOCs).** In: 24th Conference on Pattern Languages of Programs (PLoP). Vancouver, Canada, 2017.
5	2017	MOOCs in SEE	FASSBINDER, A. G. O.; FASSBINDER, M; BARBOSA, E. F. and MAGOULAS, G. **Massive Open Online Courses in Software Engineering Education**. In: 47th IEEE Frontiers in Education (FIE) Conference. Indianapolis, USA, 2017.
6	2016	Towards LDF4MOOCs	FASSBINDER, A. G. O.; BARBOSA, E.F. and MAGOULAS, G. **A Contribution to the Design of Learning in Massive Open Online Courses (MOOCs)**. In: VIII Association of Brazilian Postgraduate Students and Researchers in the United Kingdom (ABEP-UK), Research and Development: Shaping the Future of Brazil, King´s College London, London, 2016.
7	2016	Towards LDF4MOOCs	FASSBINDER, A. G. O.; FASSBINDER, M.; BARBOSA, E. F., and MAGOULAS, G. **Towards a MOOC Design Model based on Flipped Learning and Patterns: A Case on Introductory Courses**. In: XXI Congresso Internacional de Tecnologia Educativa (TISE), Santiago, Chile, 2016.
8	2016	Pedagogical requirements for MOOC Platforms	FASSBINDER, A. G. O.; FASSBINDER, M. and BARBOSA, E. F. **Um Conjunto Preliminar de Requisitos Pedagógicos para Caracterização e Comparação de Plataformas de MOOCs**. In: XXI Congresso Internacional de Tecnologia Educativa (TISE), Santiago, Chile, 2016.
9	2015	Flipped Learning as a pedagogical strategy for the LDF4MOOCs framework	FASSBINDER, A. G. O.; FASSBINDER, M. and BARBOSA, E. F. **From flipped classroom theory to the personalized design of learning experiences in MOOCs**. In: 45th IEEE Frontiers in Education (FIE) Conference. El Paso, USA, 2015.
10	2014	Systematic Review on MOOCs	FASSBINDER, A. G. O.; DELAMARO, M. E. e BARBOSA, E. F. **Construção e Uso de MOOCs: Uma Revisão Sistemática**. In: XXV Simpósio Brasileiro de Informática na Educação (SBIE), Dourados, MS, Brasil, 2014.

Source: Elaborated by the author.

Furthermore, the following papers have been produced and submitted to international journals:

- *Towards a Learning Design Framework for MOOCs*. By Aracele G. O. Fassbinder (USP/ICMC; IFSULDEMINAS); George D. Magoulas (Birkbeck College – University of London); and Ellen Francine Barbosa (USP/ICMC). Submission: Computers and Education.
- *Designing for Learning in MOOCs: A Systematic Mapping of Publications from 2008 to 2018*. By Aracele G. O. Fassbinder (USP/ICMC; IFSULDEMINAS) and Ellen Francine Barbosa (USP/ICMC). Submission: Informatics and Education.

In addition, other works indirectly related to this Ph.D. research have been published (Table 59):

Table 59 - Other related publications.

Seq	Year	Main subject	Reference
1	2017	Lifelong Learning	FASSBINDER, A. G. O.; FIORAVANTI, M. L.; OLIVEIRA, C. D.; ARIMOTO, M. M. e BARBOSA E.F. **Repensando o Desenvolvimento de Tecnologias Computacionais de Apoio à Aprendizagem ao Longo da Vida**. In: XXXVII Congresso da Sociedade Brasileira de Computação, 6º Desafie. São Paulo, Brasil, 2017.
2	2017	Tool to support the evaluation of MOOC Learning Maps	SILVA, V. M.; BARBOSA, E. F. e FASSBINDER, A.G. O. **Ferramenta Web de Apoio à Validação de Mapas de Aprendizagem para MOOCs**. In: III Concurso integrado de desenvolvimento de soluções de tecnologia e objetos de aprendizagem para a educação (APPS.EDU – CBIE). Recife, Pernambuco, Brasil, 2017.
3	2017	Tool to support the management of Educational Design Patterns and Pattern Languages	SILVA, J. M.; BARBOSA, E. F.; FIORAVANTI, M. L. e FASSBINDER, A. G. O. **Uma Ferramenta de Apoio ao Gerenciamento de Padrões para Propósitos Pedagógicos**. In: III Concurso integrado de desenvolvimento de soluções de tecnologia e objetos de aprendizagem para a educação (APPS.EDU – CBIE). Recife, Pernambuco, Brasil, 2017.
4	2016	MOOCs in the context of the IFSULDEMINAS	FASSBINDER, A. G. O. e BARBOSA, E. F. **MOOCs: Um Survey no Contexto do IFSULDEMINAS**. In: 8ª Jornada Científica e Tecnológica e 5º Simpósio de Pós-Graduação do IFSULDEMINAS. Passos, Minas Gerais, 2016.
5	2014	Understanding the application of Flipped Learning in a face-to-face course	FASSBINDER, A. G. O.; BOTELHO, T. G.; MARTINS, R. J. and BARBOSA, E. F. **Applying flipped classroom and problem-based learning in a CS1 course**. In: IEEE Frontiers in Education (FIE) Conference. Madrid, Spain, 2014.
6	2014	Understanding the application of Flipped Learning in a face-to-face course	FASSBINDER, A. G. O.; MOREIRA, D.; CRUZ, G. and BARBOSA, E.F. **Tools for the flipped classroom model: An experiment in teacher education**. In: IEEE Frontiers in Education (FIE) Conference. Madrid, Spain, 2014.

Source: Elaborated by the author.

7.5 Studies Resulting from this Research

Finally, in this section we highlight the studies derived from this Ph.D. work. Currently, a master's work to investigate the proposition of a Pattern Language to support the creation of open educational resources in format of educational videos for the MOOC context is under development. The main goal is to define a set of pedagogical and technical requirements needed in the production of videos for the massive, open and online context. Such requirements and the related knowledge will be formalized through patterns and pattern language and integrated to the original language proposed in our work.

In the context of the IFSULDEMINAS – Campus Muzambinho, in 2017, we supervised two under graduation final works. The first one was entitled *Learning Mosaic Web Tool: Apoio à Autorregulação da Aprendizagem*, aiming at developing a web tool to support teachers and learners in the process of self-regulated learning (Figure 55). The problem approached by the work arose from the *Case Study: Agile Software Development MOOC* (Section 6.2). In general, the tool allows students to define their learning goals using post-its of different colors, and to generate a mural of knowledge that must be updated throughout a teaching activity (i.e., a course, a workshop).

Figure 55 - Example of Learning Mosaic and the post-its related to each learning goal defined by a student.

Source: (BARBOSA, 2017).

The second under graduation final work supervised was entitled *OpenEdu Patterns: Uma Ferramenta Web de Apoio ao Gerenciamento de Padrões para Propósitos Educacionais*. The work presents *OpenEdu Patterns*, a web tool that allows the management of patterns and educational pattern languages as well as the search for educational practices described as patterns. Teachers can use the tool to formalize and store knowledge related to experience in teaching practices. They can also use it to find practices shared by other colleagues, which can be applied in their respective contexts to enhance teaching and learning. Preliminary findings are published in (SILVA et al., 2017).

Still in the IFSULDEMINAS – Campus Muzambinho context, the *Laboratório de Tecnologias de Software e Computação Aplicada à Educação* (LabSoft[86]) offers students with background in Computer Science and interest in Education the opportunity to take part in the development of technology tools to support learning design in MOOCs. Two main tools have been developed.

The first one uses the patterns proposed in this thesis to develop a learning design web tool[87] that will guide the creation of MOOC Learning Maps. The demand for this type of authoring tool emerged from the Field Evaluation (Section 6.4). The participants suggested a tool as an instantiation form of the proposed Educational Design Pattern Language in order to support the MOOC team during the planning phase. Preliminary findings were published in (SILVA; BARBOSA; FASSBINDER, 2017).

A second study seeks to identify the requirements necessary to develop an interactive case-based online repository[88]. The idea arose from the *Case Study: Introduction to Software Testing MOOC* (Section 6.2). Such MOOC was based on the Case-Based Learning approach and we faced many challenges to find appropriate cases, mainly in Portuguese. Thus, the repository allows teachers to insert educational cases related to their areas of study and work, search and reuse the cases shared by other educators, and interact to each other by commenting the cases.

According to Zhu, Sari and Lee (2018), the number of MOOCs and associated studies continues to expand. However, more MOOC empirical studies are still required. Thus, we intend to consider the limitations and future work summarized in Section 7.3 and keep our investigation on the massive, open and online domain.

---

[86] labsoft.muz.ifsuldeminas.edu.br/
[87] http://labsoft.muz.ifsuldeminas.edu.br/projetos/mapa/
[88] http://labsoft.muz.ifsuldeminas.edu.br/projetos/casos/

REFERENCES

ABRAHAM, G. **Evaluating a Pattern Language as Shared Language for Interaction Design**. HCI Consortium. **Anais**...2008 Disponível em: <http://www.pages.drexel.edu/~sga72/docs/sharedLanguage.pdf>

ABRAMI, P. C.; BERNARD, R. M. Research on Distance Education: In defense of field experiments. **Distance Education**, v. 27, n. 1, p. 5–26, 2006.

AKKER, J. VAN DEN et al. Introducing Educational Design Research. **Educational Design Research**, n. 2004, p. 3–7, 2006.

ALARIO-HOYOS, C. et al. Proposal for a Conceptual Framework for Educators to Describe andDesign MOOCs. **Journal of Universal Computer Science**, v. 20, n. 1, p. 6–23, 2014.

ALEXANDER, C.; ISHIKAWA, S.; SILVERSTEIN, M. **A Pattern Language: towns, building, construction**. [s.l: s.n.].

ANDERS, A. Theories and Applications of Massive Online Open Courses (MOOCs) : The Case for Hybrid Design. **The International Review of Research in Open and Distributed Learning**, v. 16, n. 6, 2015.

ANDERSON, T.; SHATTUCK, J. Design-Based Research: A Decade of Progress in Education Research? **Educational Researcher**, v. 41, n. 1, p. 16–25, 2012.

ARIMOTO, M. M. **Agile development of open educational resources**. [s.l.] University of São Paulo, 2016.

ARIMOTO, M. M.; BARROCA, L.; BARBOSA, E. F. AM-OER: An agile method for the development of open educational resources. **Informatics in Education**, v. 15, n. 2, p. 205–233, 2016.

BANNAN, B. The Integrative Learning Design Framework: An Illustrated Example from the Domain of Instructional Technology. In: NIEVEEN, T. P. & N. (Ed.). . **Educational Design Research**. Enschede: [s.n.]. p. 114–133.

BARAB, S.; SQUIRE, K. Design-Based Research: Putting a Stake in the Ground. **Journal of the Learning Sciences**, v. 13, n. 1, p. 1–14, 2004.

BARBOSA, M. C. **Learning Mosaic Web Tool: Apoio à Autorregulação da Aprendizagem**. Muzambinho-MG: [s.n.].

BARROCA, L.; KEAR, K. **Agile practices taught online at a distance**. (European Association of Distance Teaching Universities, Ed.)The Online, Open and Flexible Higher Education Conference. **Anais**...Rome, Italy: 2016 Disponível em: <https://conference.eadtu.eu/download2415>

BASILI, V. R.; DIETER ROMBACH, H. The TAME Project: Towards Improvement-Oriented Software Environments. **IEEE Transactions on Software Engineering**, v. 14, n. 6, p. 758–773, 1988.

BERGIN, J. et al. **Pedagogical Patterns: Advice For Educators**. [s.l: s.n.].

BERGIN, J. **Writing Patterns - Software, Organizational, Pedagogical**. [s.l.] Slant Flying Press, 2013.

BERGIN, J. et al. Assessment-driven Course Design Foundational Patterns. **Proceedings of the 20th European Conference on Pattern Languages of Programs**, p. 31:1--31:13, 2015a.

BERGIN, J. et al. **Assessment-Driven Course Design – Fair Play Patterns**. Proceedings of the 22nd Conference on Pattern Languages of Programs, PLoP ’15(October 2015). **Anais**...2015b

BERGMANN, J.; SAMS, A. **Flip Your Classroom Reach Every Student in Every Class Every DayGet Abstract Compressed Knowledge**, 2014.

BIOLCHINI, J. et al. Systematic Review in Software Engineering. **Engineering**, v. 679, n. May, p. 1–31, 2005.

BISHOP, J. L.; VERLEGER, M. A. **The flipped classroom: A survey of the research**. ASEE Annual Conference and Exposition, Conference Proceedings. **Anais**...2013 Disponível em: <http://www.scopus.com/inward/record.url?eid=2-s2.0-84884318608&partnerID=tZOtx3y1>

BLANCO, Á. F.; GARCÍA-PEÑALVO, F. J.; SEIN-ECHALUCE, M. **A methodology proposal for developing adaptive cMOOC**. Proceedings of the First International Conference on Technological Ecosystem for Enhancing Multiculturality - TEEM '13. **Anais**...2013 Disponível em: <http://dl.acm.org/citation.cfm?doid=2536536.2536621>

BOZKURT, A.; AKGÜN-ÖZBEK, E.; ZAWACKI-RICHTER, O. Trends and Patterns in Massive Open Online Courses: Review and Content Analysis of Research on MOOCs (2008-2015). **The International Review of Research in Open and Distributed Learning**, v. 18, n. 5, 2017.

BRAGA, R. T. V. **Um Processo para Construção e Instanciação de Frameworks baseados em uma Linguagem de Padrões para um Domínio Específico**. [s.l.] University of São Paulo, 2003.

BRAGA, R. T. V.; RÉ, R.; MASIERO, P. C. **A Process to Create Analysis Pattern Languages for Specific Domains.** Proceedings of SugarLoafPLoP. **Anais**...2007

BRANCH, R. M. **Instructional design: The ADDIE approach**. [s.l: s.n.].

BROUNS, F. et al. A networked learning framework for effective MOOC design: the ECO project approach. **In A. M. Teixeira, & A. Szücs (Eds.), 8th EDEN Research Workshop. Challenges for Research into Open & Distance Learning: Doing Things Better: Doing Better Things. Budapest, Hungary: EDEN. Oxford, United Kingdom.**, p. 161–171, 2014.

BUSCHMANN, F. et al. Pattern-Oriented Software Architecture Volume 1: A System of Patterns. **Wiley**, v. Vol. 1, p. 457, 1996.

CAFISO, S.; DI GRAZIANO, A.; PAPPALARDO, G. Using the Delphi method to evaluate opinions of public transport managers on bus safety. **Safety Science**, v. 57, p. 254–263, 2013.

CARVALHO, L.; GOODYEAR, P. Design, learning networks and service innovation. **Design Studies**, 2017.

CHEN, N.; RABB, M. A pattern language for Screencasting. **Proceedings of the 16th Conference on Pattern Languages of Programs. ACM, 2009.**, 2009.

CLOW, D. **The Learning Analytics Cycle: Closing the Loop EffectivelyInternational Conference on Learning Analytics and Knowledge**, 2012.

COBB, P. et al. Design Experiments in Educational Research. **Educational Researcher**, v. 32, n. 1, p. 9–13, 2003.

COHN, M. **User Stories Applied: For Agile Software Development**. [s.l: s.n.]. v. 1

CONOLE, G. et al. A new methodology for learning design. **Learning**, v. Vienna, Au, 2008.

CONOLE, G. A New Classification Schema for MOOCs. **The International Journal for Innovation and Quality in Learning**, n. 3, p. 65–77, 2014a.

CONOLE, G. **The 7Cs of Learning Design – A new approach to rethinking design practice**. 9th International Conference on Networked Learning. **Anais**...2014b Disponível em: <http://www.lancaster.ac.uk/fss/organisations/netlc/past/nlc2014/abstracts/pdf/conole.pdf>

COOPER, S.; SAHAMI, M. Reflections on Stanford's MOOCs. **Communications of the ACM**, v. 56, n. 2, p. 28, 2013.

COPLIEN, J. O. **A pattern language for writers' workshops**. Proceedings of the 2nd European

Conference on Pattern Languages of Programming (EuroPLoP '97). Siemens Technical Report 120/SW1/FB. **Anais**...1997 Disponível em: <http://dirkriehle.com/community-service/hillside-group/europlop-1997/p2final.pdf>

CROSS, S. Evaluation of the OLDS MOOC curriculum design course : participant perspectives , expectations and experiences. **OLDS MOOC Project**, p. 21, 2013.

DALZIEL, J. et al. **The Larnaca Declaration on Learning Design – 2013**. [s.l: s.n.]. Disponível em: <https://platform.europeanmoocs.eu/users/65/LarnacaDeclaration2013.pdf>.

DALZIEL, J. et al. The Larnaca Declaration on Learning Design. **Journal of Interactive Media in Education**, v. 2016, n. 7, p. 1–24, 2016.

DE O. MELO, C. et al. The evolution of agile software development in Brazil: Education, research, and the state-of-the-practice. **Journal of the Brazilian Computer Society**, v. 19, n. 4, p. 523–552, 2013.

DE VILLIERS, M. R. (RUTH); HARPUR, P. A. Design-based research - the educational technology variant of design research. **Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference on - SAICSIT '13**, p. 252, 2013.

DICKENS, K.; WHITE, S. **Mentoring the Masses : MOOC Mentor Interventions Towards a Connected Learning Community**. Conference: eMOOCs 2015, At Mons, Belgium. **Anais**...2015

DIESTE, O.; GRIMÁN, A.; JURISTO, N. Developing search strategies for detecting relevant experiments. **Empirical Software Engineering**, v. 14, n. 5, p. 513–539, 2009.

DOWNES, S. Places to Go: Connectivism & Connective Knowledge. **Innovate: Journal of Online Education**, v. 5, n. 1, 2008.

DOWNES, S. **Connectivism and Connective Knowledge: essays on meaning and learning networks**. [s.l: s.n.].

DOWNES, S. The Quality of Massive Open Online Courses. **International Handbook of E-Learning Volume 1: Theoretical Perspectives and Research**, p. 426, 2013.

EPPARD, J.; ROCHDI, A. **A Framework for Flipped Learning**. 13th International Conference Mobile Learning. **Anais**...2017

FASSBINDER, A. G. O.; FASSBINDER, M.; BARBOSA, E. F. FRANCINE; MAGOULAS, G. **Towards a MOOC Design Model based on Flipped Learning and Patterns: A Case on Introductory Courses**. XXI Conferência Internacional sobre Informática na Educação. **Anais**...Santiago, Chile: 2016

FASSBINDER, A. G. O.; BARBOSA, E. F. **Estudo e Aplicação da técnica Learning Mosaic no apoio à autorregulação da aprendizagem em Cursos Abertos Online e Massivos (MOOCs)**. Anais do Workshop de Informática na Escola (WIE). **Anais**...Recife-PE: Congresso Brasileiro de Informática na Educação (CBIE), 27 Oct. 2017 Disponível em: <http://www.br-ie.org/pub/index.php/wie/article/view/7281>

FASSBINDER, A. G. O.; DELAMARO, M. E.; BARBOSA, E. F. **Construção e Uso de MOOCs: Uma Revisão Sistemática**. Brazilian Symposium on Computers in Education (Simpósio Brasileiro de Informática na Educação - SBIE). **Anais**...2014 Disponível em: <http://br-ie.org/pub/index.php/sbie/article/view/2959>

FASSBINDER, A. G. O. et al. **Tools for the flipped classroom model: An experiment in teacher education**. Proceedings - Frontiers in Education Conference, FIE. **Anais**...2014

FASSBINDER, A. G. O. et al. **Torwards a MOOC model based on Flipped Classroom principles**. (J. Sánchez, Ed.)Nuevas Ideas en Informática Educativa, Volumen 12. **Anais**...Santiago, Chile: 2016

FASSBINDER, A. G. O. et al. **Massive open online courses in software engineering education**. 2017 IEEE Frontiers in Education Conference (FIE). **Anais**...Indianapolis: IEEE, Oct. 2017 Disponível em: <http://ieeexplore.ieee.org/document/8190588/>

FASSBINDER, A. G. O. et al. **Massive Open Online Courses on Web Development Education: A Case Study**. 48th Annual Frontiers in Education (FIE) Conference. **Anais**...San Jose, California, USA: 2018

FASSBINDER, A. G. O.; BARBOSA, E. F.; MAGOULAS, G. D. Developing an Educational Design Pattern Language for MOOCs. **Brazilian Symposium on Computers in Education (Sbie 2017)**, n. Cbie, p. 456–465, 2017a.

FASSBINDER, A. G. O.; BARBOSA, E. F.; MAGOULAS, G. D. **Towards an Educational Design Pattern Language for Massive Open Online Courses**. 24th Conference on Pattern Languages of Programs (PLoP). **Anais**...Vancouver, Canada: 2017b

FASSBINDER, A. G. O.; FASSBINDER, M.; BARBOSA, E. F. **From flipped classroom theory to the personalized design of learning experiences in MOOCs**. Proceedings - Frontiers in Education Conference, FIE. **Anais**...2015

FASSBINDER, A. G. O.; FASSBINDER, M.; BARBOSA, E. F. **Um Conjunto Preliminar de Requisitos Pedagógicos para Caracterização e Comparação de Plataformas de MOOCs**. (J. Sánchez, Ed.)Nuevas Ideas en Informática Educativa. **Anais**...Santiago de Chile: 2016 Disponível em: <http://www.tise.cl/volumen12/TISE2016/167-176.pdf>

FAVIER, T. T.; VAN DER SCHEE, J. A. Exploring the characteristics of an optimal design for inquiry-based geography education with Geographic Information Systems. **Computers and Education**, v. 58, n. 1, p. 666–677, 2012.

FELIZARDO, K. R. et al. Using Forward Snowballing to update Systematic Reviews in Software Engineering. **Proceedings of the 10th ACM/IEEE International Symposium on Empirical Software Engineering and Measurement - ESEM '16**, n. September, p. 1–6, 2016.

FIDALGO-BLANCO, Á.; SEIN-ECHALUCE, M. L.; GARCÍA-PEÑALVO, F. J. From massive access to cooperation: lessons learned and proven results of a hybrid xMOOC/cMOOC pedagogical approach to MOOCs. **International Journal of Educational Technology in Higher Education**, v. 13, n. 1, 2016.

FILATRO, A. **Design Instrucional na Prática**. [s.l.] Pearson, 2008.

FINI, A. et al. IntroOpenEd 2007 : an experience on Open Education by a virtual community of teachers. **Journal of eLearning and Knowledge Society**, v. 4, n. 1, p. 231–239, 2008.

FIORAVANTI, M. L.; BARBOSA, E. F. **A systematic mapping on pedagogical patterns**. Proceedings - Frontiers in Education Conference, FIE. **Anais**...2016

FIRSSOVA, O.; BROUNS, F.; KALZ, M. Designing for open learning: Design principles and scalability affordances in practice. **L@S 2016 - Proceedings of the 3rd 2016 ACM Conference on Learning at Scale**, p. 249–252, 2016.

FLEISS, J. L. Measuring nominal scale agreement among many raters. **Psychological Bulletin**, v. 76, n. 5, p. 378–382, 1971.

FOWLER, M. **Writing software patterns**. Disponível em: <https://www.martinfowler.com/articles/writingPatterns.html#CommonPatternForms>. Acesso em: 21 dec. 2017.

FRANCO, L.; BRAGA, D; RODRIGUES, A. . **EaD Virtual Entre Teoria e Prática**. [s.l.] UNIFEI, 2010.

GALWAY, L. P. et al. A novel integration of online and flipped classroom instructional models in public health higher education. **BMC medical education**, v. 14, n. 1, p. 181, Jan. 2014.

GAMMA, E. et al. Design Patterns: Abstraction and Reuse of Object-Oriented Design. **Lecture Notes in Computer Science**, v. 707, n. Mvc, p. 406–431, 1993.

GAMMA, E. et al. Design Patterns: Elements of Reusable Software. **Addison-Wesley Professional Computing Series**, p. 395, 1996.

GAMMA, E. et al. **Design Patterns – Elements of Reusable Object-Oriented Software**. [s.l: s.n.].

GAY, G.; DJAFAROVA, N.; ZEFI, L. **Teaching Accessibility to the Masses**. Proceedings of the 14th Web for All Conference on The Future of Accessible Work - W4A '17. **Anais**...2017 Disponível em: <http://dl.acm.org/citation.cfm?doid=3058555.3058563>

GOODYEAR, P. **Patterns , pattern languages and educational design**. Beyond the comfort zone: Proceedings of the 21st ASCILITE Conference. **Anais**...2004 Disponível em: <http://ascilite.org.au/conferences/perth04/procs/pdf/goodyear.pdf>

GOODYEAR, P. et al. Towards a Pattern Language for Networked Learning. **Networked learning**, p. 449–455, 2004.

GOODYEAR, P. Educational design and networked learning: Patterns, pattern languages and design practice. **Australasian Journal of Educational Technology**, v. 21, n. 1, p. 82–101, 2005.

GOODYEAR, P. Teaching as design. **HERDSA Review of Higher Education Volume 2**, v. 2, p. 27–50, 2015.

GUÀRDIA, L.; MAINA, M.; SANGRÀ, A. MOOC Design Principles. A Pedagogical Approach from the Learner's Perspective. **eLearning Papers**, v. 33, n. May, p. 1–6, 2013.

GUERRA, E.; FERNANDES, C. An Evaluation Process for Pattern Languages. **In Proceedings of the 8th Latin American Conference on Pattern Languages of Programs**, p. 11, 2010.

GULATEE, Y.; NILSOOK, P. **Elements of Learning Design for MOOCs**. The Fifth TCU International E-learning Conference. **Anais**...2014

HAMDAN, N. et al. The flipped learning model: A white paper based on the literature review titled a review of flipped learning. **Flipped Learning Network**, n. c, p. 1–15, 2013.

HARRISON, G. W.; LIST, J. A. Field experiments. **Journal of Economic Literature**, v. 42, n. 4, p. 1009–1055, 2004.

HARRISON, N. B. The Language of Shepherding: A Pattern Language for Shepherds and Sheep. **In Proceedings of the 6th Annual Conference on the Pattern Languages of Programs (PLoP)**, v. 5, p. 22, 1999.

HATZIPANAGOS, S. What do MOOCs contribute to the debate on learning design of online courses? **eLearning Papers**, v. 42, n. June, 2015.

HERNÁNDEZ-LEO, D. et al. Towards an integrated learning design environment. **Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)**, v. 8095 LNCS, p. 448–453, 2013.

HEW, K. F. Promoting engagement in online courses: What strategies can we learn from three highly rated MOOCS. **British Journal of Educational Technology**, v. 47, n. 2, p. 320–341, 2016.

HEW, K. F.; CHEUNG, W. S. **Students' and instructors' use of massive open online courses (MOOCs): Motivations and challengesEducational Research Review**, 2014.

HOLLANDER, M.; WOLFE, D. A.; CHICKEN, E. **Nonparametric statistical methods.** [s.l: s.n.]. v. 2

HONE, K. S.; EL SAID, G. R. Exploring the factors affecting MOOC retention: A survey study. **Computers and Education**, v. 98, p. 157–168, 2016.

IBA, T. **Learning Patterns: A Pattern Language for Creative Learning (Pattern Language 3.0 Catalogue)**. [s.l.] CreativeShift Lab, 2014.

IBA, T.; MIYAKE, T. Learning patterns: A pattern language for creative learning ii. **Proceedings of the 1st Asian Conference on Pattern …**, v. 09, 2010.

IBA, T.; SAKAMOTO, M.; MIYAKE, T. How to Write Tacit Knowledge as a Pattern Language: Media Design for Spontaneous and Collaborative Communities. **Procedia - Social and Behavioral Sciences**, v. 26, p. 46–54, 2011.

JICK, T. Mixing Qualitative and Quantitative Methods: Triangulation in Action. **Administrative Science Quarterly**, v. 24, n. 4, p. 602–611, 1979.

JOKSIMOVIĆ, S. et al. Exploring development of social capital in a CMOOC through language and discourse. **Internet and Higher Education**, v. 36, p. 54–64, 2018.

KAROUDIS, K.; MAGOULAS, G. D. **An Architecture for Smart Lifelong Learning Design**. INNOVATIONS IN SMART LEARNING. **Anais**...2017

KENDALL, M. G.; SMITH, B. B. The Problem of *m* Rankings. **The Annals of Mathematical Statistics**, v. 10, n. 3, p. 275–287, 1939.

KIM, M. K. et al. The experience of three flipped classrooms in an urban university: an exploration of design principles. **The Internet and Higher Education**, v. 22, p. 37–50, Jul. 2014.

KIM, T.-H.; JIN, S.-H. Development of auditory design guidelines for improving learning on mobile phones. **Computers & Education**, v. 91, p. 60–72, 2015.

KING, C. et al. Designing for quality: The understanding dementia MOOC. **Electronic Journal of e-Learning**, v. 12, n. 2, p. 161–171, 2014.

KITCHENHAM, B. Procedures for performing systematic reviews. **Keele, UK, Keele University**, v. 33, n. TR/SE-0401, p. 28, 2004.

KITCHENHAM, B. et al. **Systematic literature reviews in software engineering-A tertiary studyInformation and Software Technology**, 2010.

KITCHENHAM, B. A; PFLEEGER, S. L. Principles of Survey Research Part 3: Constructing a Survey Instrument. **ACM SIGSOFT Software Engineering Notes**, v. 27, n. 2, p. 20, 2002.

KITCHENHAM, B.; PFLEEGER, S. L. Principles of Survey Research Part 1: Turning Lemons into Lemonade. **ACM SIGSOFT Software Engineering Notes**, v. 26, n. 6, p. 16, 2001.

KLOOS, C. D. et al. **Designing educational material**. IEEE Global Engineering Education Conference, EDUCON. **Anais**...2016

KOHLS, C.; PANKE, S. Is That True...?: Thoughts on the Epistemology of Patterns. **Proceedings of the 16th Conference on Pattern Languages of Programs**, p. 9:1--9:14, 2010.

KOPER, R.; TATTERSALL, C. Preface to Learning Design : A Handbook on Modelling and Delivering Networked Education and Training. **Journal of Interactive Media in Education**, v. 2005, p. 1–7, 2005.

KÖPPE, C. **Towards a Pattern Language for Lecture Design: An inventory and categorization of existing lecture-relevant patterns**. Proceedings of the 18th European Conference on Pattern Languages of Programs, EuroPLoP'13. **Anais**...2013

KÖPPE, C. et al. **Flipped Classroom Patterns: Designing Valuable In-class Meetings**. Proceedings of the 20th European Conference on Pattern Languages of Programs. **Anais**...2015 Disponível em: <http://doi.acm.org/10.1145/2855321.2855348>

KÖPPE, C.; SCHALKEN-PINKSTER, J. **Lecture design patterns**. Proceedings of the 18th European Conference on Pattern Languages of Program - EuroPLoP '13. **Anais**...2015 Disponível em:

<http://dl.acm.org/citation.cfm?doid=2739011.2739015>

KRATHWOHL, D. R. A Revision of Bloom's Taxonomy: An Overview. **Theory Into Practice**, v. 41, n. 4, p. 212–218, 2002.

KUKHARENKO, V. **Designing massive open online courses**. CEUR Workshop Proceedings. **Anais**...2013

LACKNER, E.; EBNER, M.; KHALIL, M. MOOCs as granular systems: design patterns to foster participant activity. **eLearning Papers**, v. 42, n. June, p. 28–37, 2015.

LANDIS, J. R.; KOCH, G. G. The Measurement of Observer Agreement for Categorical Data. **Biometrics**, v. 33, n. 1, p. 159, 1977.

LANE, A.; CAIRD, S.; WELLER, M. The potential social, economic and environmental benefits of MOOCs: operational and historical comparisons with a massive 'closed online' course. **Open Praxis**, v. 6, n. 2, 2014.

LAURILLARD, DIANA, AND D. L. Evaluating learning designs through the formal representation of pedagogical patterns. **IGI Global**, 2011.

LAURILLARD, D. **Rethinking university teaching: A conversational framework for the effective use of learning technologies**. [s.l: s.n.]. v. 2nd

LAURILLARD, D. Teaching as a Design Science: Building Pedagogical Patterns for Learning and Technology . By Diana Laurillard. **British Journal of Educational Studies**, v. 60, n. 4, p. 448–450, 2012a.

LAURILLARD, D. **Teaching as a design science: Building pedagogical patterns for learning and technology**. [s.l: s.n.].

LAZAR, J.; FENG, J. H. J.; HOCHHEISER, H. **Research methods in human-computer interaction**. [s.l: s.n.].

LEE, G. et al. A study on the development of a MOOC design model. **Educational Technology International**, v. 17, n. 1, p. 1–37, 2016.

LI, Y. et al. **MOOE: A new online education mode: Virtual simulation experiment MOOE platform for FPGA**. Proceedings - Frontiers in Education Conference, FIE. **Anais**...2016

LIM, B. B. L. **Teaching Web development technologies in CS/IS curricula**. Proceedings of the twenty-ninth SIGCSE technical symposium on Computer science education. **Anais**...Atlanta, Georgia, USA: 1998

LIYANAGUNAWARDENA, T. R.; KENNEDY, E.; CUFFE, P. Design patterns for promoting peer interaction in discussion forums in MOOCs | Open Education Europa. **eLearning Papers**, n. 42, p. 1–16, 2015.

MARGARYAN, A.; BIANCO, M.; LITTLEJOHN, A. Instructional quality of Massive Open Online Courses (MOOCs). **Computers and Education**, v. 80, p. 77–83, 2015.

MARSHALL, C.; BRERETON, P. **Tools to Support Systematic Literature Reviews in Software Engineering: A Mapping Study**. 2013 ACM / IEEE International Symposium on Empirical Software Engineering and Measurement. **Anais**...2013Disponível em: <http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=6681371>

MARTIN, F. Instructional Design and the Importance of Instructional Alignment. **Community College Journal of Research and Practice**, v. 35, n. 12, p. 955–972, 2011.

MAY, M.; NEUTSZKY-WULFF, C.; ROSTHØJ, S. A pedagogical design pattern framework - for sharing experiences and enhancing communities of practice within online and blended learning. **Læring**

& Medier (LOM), v. 16, p. 24, 2016.

MCANDREW, P.; GOODYEAR, P. Representing practitioner experiences through learning design and patterns. In: **Rethinking Pedagogy for a Digital Age: Designing and Delivering E-Learning**. [s.l: s.n.]. p. 92–102.

MCAULEY, A et al. The MOOC model for digital practice. **Massive Open Online Courses: digital ways of knowing and learning**, p. 1–64, 2010.

MCKENNEY, S. E.; REEVES, T. C. Conducting educational design research. **Recherche**, p. 256, 2012.

MEINEL, C.; TOTSCHNIG, M.; WILLEMS, C. openHPI: Evolution of a MOOC Platform from LMS to SOA. **Proceedings of the 5th International Conference on Computer Supported Education**, p. 593–598, 2013.

MESZAROS, G.; DOBLE, J. MetaPatterns: A Pattern Language for Pattern Writing. **Pattern languages of program design**, p. 1–36, 1997.

MILLER, C. S.; CONNOLLY, R. Introduction to the Special Issue on Web Development. **ACM Transactions on Computing Education (TOCE) - Special Issue on Web Development**, v. 15, n. 1, 2015.

MOLENDA, M. In Search of the Elusive ADDIE Model. **Performance Improvement**, v. 42, n. 5, p. 34–36, 2003.

MOR, Y. SNaP! Re-using, sharing and communicating designs and design knowledge using scenarios, narratives and patterns. **Handbook of Design in Educational Technology**, n. SEPTEMBER 2013, p. 189–200, 2013.

MOR, Y.; MOGILEVSKY, O. The learning design studio: Collaborative design inquiry as teachers' professional development. **Research in Learning Technology**, v. 21, 2013.

MOR, Y.; WARBURTON, S. Practical Patterns for Active and Collaborative MOOCs: Checkpoints, FishBowl and See Do Share. **eLearning Papers**, v. 42, 2015.

MOR, Y.; WARBURTON, S.; WINTERS, N. **Participatory pattern workshops: A methodology for open learning design inquiry**. Research in Learning Technology. **Anais**...2012

NEWMAN, D. L. et al. **Promoting Active Learning Through the Flipped Classroom Model**. [s.l: s.n.]. v. i

NIEVEEN, N. **Educational design research: An introduction**. An introduction to educational design research. **Anais**...2009

NKUYUBWATSI, B. **Cultural Translation in Massive Open Online Courses (MOOCs)**. eLearning Papers. **Anais**...2014

NOKELAINEN, P. An empirical assessment of pedagogical usability criteria for digital learning material with elementary school students. **Educational Technology and Society**, v. 9, n. 2, p. 178–197, 2006.

NULDEN, U. **Thematic modules in asynchronous learning network: Designing introductory courses**. Proceedings of the 1999 32nd Annual Hawaii International Conference on System Sciences, HICSS-32. **Anais**...1999 Disponível em: <http://www.scopus.com/inward/record.url?eid=2-s2.0-0032714996&partnerID=40&md5=858fff353f0593a877a015538a07f10e>

ONAH, D. F. O.; SINCLAIR, J.; BOYATT, R. Dropout rates of massive open online courses : behavioural patterns. **EDULEARN14 Proceedings**, p. 5825–5834, 2014.

OSTERWALDER, A.; PIGNEUR, Y. **Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers**. [s.l: s.n.].

PONTI, M. **Hei mookie! Where do i start? The role of artifacts in an unmanned MOOC**. Proceedings of the Annual Hawaii International Conference on System Sciences. **Anais**...2014

PORTER, D.; BEALE, R. **A Policy Brief on MOOCs**. [s.l: s.n.].

PRESSMAN, R. S. **Software Engineering A Practitioner's Approach 7th Ed - Roger S. Pressman**. [s.l: s.n.].

PRESSMAN, R. S.; MAXIM, B. R. **SOFTWARE ENGINEERING: A PRACTITIONER'S APPROACH**. EIGHTH EDI ed. [s.l: s.n.].

REBECCA A. CROXTON AND ANTHONY S. CHOW. **Using ADDIE and Systems Thinking as the Framework for Developing a MOOC: A Case Study**. (Michael Simonson, Ed.)37th Annual proceedings - Practice of Educational Communications and Technology. **Anais**...Nova Southeastern University, North Miami Beach, Florida: 2014

REEVES, T. Can educational research be both rigorous and relevant? **Educational Designer**, v. 1, p. 1–24, 2011.

RICHEY, RITA C., AND J. D. K. **Design and development research: Methods, strategies, and issues**. [s.l.] Routledge, 2014.

RICO, D. F.; SAYANI, H. H. Use of Agile Methods in Software Engineering Education. **2009 Agile Conference**, p. 1–12, 2009.

RIENTIES, B.; TOETENEL, L. The impact of learning design on student behaviour, satisfaction and performance: A cross-institutional comparison across 151 modules. **Computers in Human Behavior**, v. 60, p. 333–341, 2016.

ROMERO, M.; USART, M. **Serious games integration in an entrepreneurship Massive Online Open Course (MOOC)**. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics). **Anais**...2013

ROSS, J. et al. Teacher Experiences and Academic Identity: The Missing Components of MOOC Pedagogy. **MERLOT Journal of Online Learning and Teaching**, v. 10, n. 1, p. 57–69, 2014.

ROTELLAR, C.; CAIN, J. **Research, perspectives, and recommendations on implementing the flipped classroomAmerican Journal of Pharmaceutical Education**, 2016.

ROYTEK, M. A. Enhancing instructional design efficiency: Methodologies employed by instructional designers. **British Journal of Educational Technology**, v. 41, n. 2, p. 170–180, 2010.

RUBENS, W. Improving the Learning Design of Massive Open Online Courses. **Turkish Online Journal of Educational Technology - TOJET**, v. 13, n. 4, p. 71–80, 2014.

SAHASRABUDHES, S.; MAJUMDAR, R. **Content Creation and Pedagogic Strategies for Skill Development MOOC**. Proceedings of the 24th International Conference on Computers in Education. India: Asia-Pacific Society for Computers in Education. **Anais**...2016

SALMON, G. et al. Experiential online development for educators: The example of the Carpe Diem MOOC. **British Journal of Educational Technology**, v. 46, n. 3, p. 542–556, 2015.

SALMON, G.; WRIGHT, P. Transforming Future Teaching through "Carpe Diem" Learning Design. **Educ. Sci**, v. 4, p. 52–63, 2014.

SAMS, A.; BERGMANN, J. Flip Your Students' Learning. **Educational Leadership**, v. 70, n. 6, p. 16–20, 2013.

SANTOS-ESPINO, B. J. M.; AFONSO-SUÁREZ, M. D.; GUERRA-ARTAL, C. Speakers and Boards : A Survey of Instructional Video Styles in MOOCs. **Technical Communication**, v. 63, n. 2, p. 101–115, 2016.

SANTOS, T.; COSTA, C. J.; APARICIO, M. METAVERSIA A proposal for a Drupal based MOOC publisher. **OSDOC '13 Proceedings of the Workshop on Open Source and Design of Communication**, p. 25–32, 2013.

SCHOPHUIZEN, M. et al. Eliciting the challenges and opportunities organizations face when delivering open online education: A group-concept mapping study. **Internet and Higher Education**, v. 36, p. 1–12, 2018.

SEIN, M. K. et al. Action design research. **MIS Quarterly**, v. 30, n. 3, p. 611–642, 2011.

SERGIS, S.; SAMPSON, D. G.; PELLICCIONE, L. Educational design for moocs: Design considerations for technology-supported learning at large scale. In: **Lecture Notes in Educational Technology**. [s.l: s.n.]. p. 39–71.

SHANI, A. B. (RAMI); DOCHERTY, P. **Learning by Design: Building Sustainable Organizations**. [s.l.] Wiley-Blackwell, 2003.

SHAPIRO, H. B. et al. Understanding the massive open online course (MOOC) student experience: An examination of attitudes, motivations, and barriers. **Computers and Education**, v. 110, p. 35–50, 2017.

SHARIF, A.; CHO, S. 21st-Century Instructional Designers: Bridging the Perceptual Gaps between Identity, Practice, Impact and Professional Development. **RUSC. Universities and Knowledge Society Journal**, v. 12, n. 3, p. 72, 2015.

SILVA, J. M. DA et al. **Uma Ferramenta de Apoio ao Gerenciamento de Padrões para Propósitos Pedagógicos**. Anais do APPs.Edu, Congresso Brasileiro de Informática na Educação. **Anais**...Recife-PE: 27 Oct. 2017 Disponível em: <http://www.br-ie.org/pub/index.php/wcbie/article/view/7402>

SILVA, V. M.; BARBOSA, E. F.; FASSBINDER, A. **Ferramenta Web de Apoio à Validação de Mapas de Aprendizagem para MOOCs**. Anais do APPs.Edu, Congresso Brasileiro de Informática na Educação. **Anais**...Recife-PE: 27 Oct. 2017 Disponível em: <http://www.br-ie.org/pub/index.php/wcbie/article/view/7401>

SMITH, N. et al. A comparison of MOOC development and delivery approaches. **International Journal of Information and Learning Technology**, v. 34, n. 2, p. 152–164, 2017.

SPECTOR, J. M.; MERRILL, M. D. **Innovations in instructional technology: essays in honor of M. David Merrill**. [s.l: s.n.]. v. 37

SPYROPOULOU, N.; PIERRAKEAS, C.; KAMEAS, A. Creating Mooc Guidelines Based on Best Practices. **EDULEARN14 Proceedings**, p. 6981–6990, 2014.

STAUBITZ, T. et al. **Improving the Peer Assessment Experience on MOOC Platforms**. Proceedings of the Third (2016) ACM Conference on Learning @ Scale - L@S '16. **Anais**...2016 Disponível em: <http://dl.acm.org/citation.cfm?doid=2876034.2876043>

SWAN, K. et al. AMP: A tool for characterizing the pedagogical approaches of MOOCs. **e-mentor**, v. 2, p. 75–85, 2014.

THORPE, M. Perceptions about Time and Learning: Researching the Student Experience. In: **Distance and E-Learning in Transition: Learning Innovation, Technology and Social Challenges**. [s.l: s.n.]. p. 457–472.

THURMOND, V. A. The point of triangulation. **Journal of nursing scholarship**, v. 33, n. 3, p. 253–258, 2001.

TOETENEL, L.; RIENTIES, B. Analysing 157 learning designs using learning analytic approaches as a means to evaluate the impact of pedagogical decision making. **British Journal of Educational Technology**, v. 47, n. 5, p. 981–992, 2016.

TOVEN-LINDSEY, B.; RHOADS, R. A.; LOZANO, J. B. Virtually unlimited classrooms: Pedagogical practices in massive open online courses. **Internet and Higher Education**, v. 24, p. 1–12, 2015.

TRACEY, M. W. Design and development research: A model validation case. **Educational Technology Research and Development**, v. 57, n. 4, p. 553–571, 2009.

VALLE, P. H.; BARBOSA, E. F.; MALDONADO, J. C. **Um Mapeamento Sistemático sobre Ensino de Teste de Software**. (CBIE-LACLO, Ed.)Anais do XXVI Simpósio Brasileiro de Informática na Educação (SBIE). **Anais**...26 Oct. 2015 Disponível em: <http://br-ie.org/pub/index.php/sbie/article/view/5119>

VALLE, P. H. D.; BARBOSA, E. F.; MALDONADO, J. C. **CS curricula of the most relevant universities in Brazil and abroad: Perspective of software testing education**. 2015 International Symposium on Computers in Education, SIIE 2015. **Anais**...2016

VESPER, J.; REEVES, T.; HERRINGTON, J. The Application of Expert Review as a Formative Evaluation Strategy within an Educational Design Research Study. **E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2011**, p. 973–978, 2011.

WARBURTON, S.; MOR, Y. A set of patterns for the structured design of MOOCs. **Open Learning: The Journal of Open, Distance and e-Learning**, v. 30, n. 3, p. 206–220, 2015.

WELLHAUSEN, T.; FIESSER, A. **How to write a pattern?** Proceedings of the 16th European Conference on Pattern Languages of Programs - EuroPLoP '11. **Anais**...2011 Disponível em: <http://dl.acm.org/citation.cfm?doid=2396716.2396721>

WOHLIN, C. et al. **Experimentation in software engineering**. [s.l: s.n.]. v. 9783642290

YIN, R. K. Case study research: design and methods. **Evaluation & Research in Education**, v. 24, n. 3, p. 221–222, 2011.

YUAN, L.; POWELL, S. MOOCs and Open Education: Implications for Higher Education. **Cetis**, p. 19, 2013.

ZHENG, S. et al. **Understanding Student Motivation, Behaviors and Perceptions in MOOCs**. Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing - CSCW '15. **Anais**...2015 Disponível em: <http://dl.acm.org/citation.cfm?doid=2675133.2675217>

ZHU, M.; SARI, A.; LEE, M. M. A systematic review of research methods and topics of the empirical MOOC literature (2014–2016). **Internet and Higher Education**, v. 37, p. 31–39, 2018.

APPENDIX

A. USE OF DATA STATEMENT

Acordo de compartilhamento de dados

O banco de dados da Plataforma de MOOCs TIM TEC do IFSULDEMINAS contém dados pessoais que precisam ser protegidos e que não podem ser publicados. O risco de vazamento de dados privados precisa ser equilibrado com os benefícios que o compartilhamento e uso destes dados vão proporcionar. A assinatura deste acordo significa que os pesquisadores se comprometem a

- ✓ Não publicar ou redistribuir estes dados a pessoas não autorizadas pelo presente acordo.
- ✓ Não disseminar dados privados e pessoais e tomar as medidas necessárias para proteger a segurança dos dados.
- ✓ Somente usar os dados para a finalidade descrita abaixo.

Os seguintes itens são recomendados, mas opcionais (assinalar se concordar)

- ☒ Publicar os resultados da pesquisa em acesso aberto
- ☒ Compartilhar software de análise usando licença livre
- ☒ Publicar dados tratados em regime de dados abertos (obedecendo boas práticas de anonimização)

Descreva aqui a finalidade do uso dos dados:

O trabalho de doutorado que está sendo desenvolvido no Instituto de Ciências Matemáticas e de Computação (ICMC – USP) tem como objetivo planejar, desenvolver e validar um framework teórico, educacional, utilizando técnicas de Engenharia de Software, especificamente Padrões e Linguagem de Padrões de Design Educacional, para apoiar educadores e designers na construção de projetos de aprendizagem para MOOCs. Uma parte do processo de validação do Framework inclui construir e ofertar MOOCs utilizando tal recurso. Alguns desses MOOCs serão disponibilizados ao público em geral por meio da plataforma Tim Tec do IFSULDEMINAS. Por isso, dados armazenados na plataforma e dados coletados por meio de questionários adicionais serão usados.

Data do início da pesquisa e uma estimativa da data final do uso dos dados. Após esta data, os pesquisadores prometem remover os dados originais (com identificadores pessoais) dos seus computadores permanecendo com os dados somente se os mesmos estiverem anonimizados.

Início: 01/03/2015 e Fim: 01/06/2018

Nome do Pesquisador responsável: Aracele Garcia de Oliveira Fassbinder (Doutoranda no ICMC – USP e professora efetiva no IFSULDEMINAS Campus Muzambinho)

Orientadora: Profa. Ellen Francine Barbosa (ICMC – USP)

Outros pesquisadores com acesso aos dados: não

Pouso Alegre - MG, 01 de Março de 2015

Aluna: Aracele Fassbinder	Orientadora: Ellen F. Barbosa	Giovane José da Silva Diretor de EaD do IFSULDEMINAS

B. FREE AND CLARIFIED CONSENT TERM

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Prezado (a) participante,

Você está sendo convidado (a) a atuar como voluntário (a) na avaliação do Framework de Apoio ao Design de Aprendizagem para MOOCs, o qual está sendo construído no âmbito da pesquisa de doutoramento de Aracele Garcia de Oliveira Fassbinder.

Tal framework é composto por três elementos: ciclo de vida para MOOCs, Linguagem de Padrões de Design Educacional e artefatos relacionados. Ele visa contribuir para o aprimoramento das estratégias pedagógicas e atividades de ensino-aprendizagem utilizadas no projeto de construção e oferta de MOOCs.

Para essa avaliação de usabilidade, adotaremos os seguintes procedimentos: O Sr. (a) fará uso de um framework instrucional, teórico, baseado em padrões de design educacional, a fim de construir um Mapa de Aprendizagem (também chamado Mapa de Atividades ou, ainda, Plano de Curso) para um MOOC no assunto a ser escolhido pelo(a) Sr. (a). Também participará de outras formas de coleta de dados, tais como questionários e/ou entrevistas que visam identificar seu ponto de vista sobre a satisfação, facilidade em aprender a usar o framework e a efetividade do mesmo, bem como sugestões para melhorias.

Para participar deste estudo o Sr. (a) não terá nenhum custo, nem receberá qualquer vantagem financeira. O Sr. (a) terá o esclarecimento sobre o estudo em qualquer aspecto que desejar e estará livre para participar ou recusar-se a participar. Poderá retirar seu consentimento ou interromper a participação a qualquer momento. Os resultados da pesquisa estarão à sua disposição quando finalizada. A participação na pesquisa poderá expor o (a) Sr.(a) a riscos mínimos, tais como “cansaço, desconforto pelo tempo gasto no preenchimento do Mapa de Aprendizagem e questionário(s), e ao relembrar algumas sensações diante do vivido com situações altamente desgastantes”. Se isto ocorrer, “o (a) Sr. (a) poderá interromper o preenchimento dos instrumentos e retomá-los posteriormente, se assim o desejar”.

Ao submeter este questionário, o Sr. (a) admite que foi informado (a) dos objetivos da avaliação, de maneira clara e detalhada, e que lhe foi dada a oportunidade de ler e esclarecer suas dúvidas. Desde já agradecemos sua participação!

Aracele Garcia de Oliveira Fassbinder - aracele.garcia@ifsuldeminas.edu.br

C. INSTRUMENT TO SUPPORT THE EVALUATION OF LEARNING MAPS IN THE MOOC CONTEXT

	Totally contemplated	Sufficiently contemplated	Partially contemplated	Not contemplated
(1) Competency-based design				
1.1) Does the project focus on skills development, inclusing situated learning strategies and active teaching methods, such as simulations, problem-based learning, project-based learning, case-based, etc.?				
1.2) Does it envisage a learning process that is more oriented to the accomplishment of activities than to the exposition and explanation of content?				
1.3) Does it include activities that stimulate the development of competencies, skills and attitudes required for the area of activity in which the course is inserted?				
1.4) Will it consist of short videos (1 to 5 minutes), used to guide students in the activities that should be developed? Is the number of videos with knowledge transmission (lectures) minimal?				
1.5) Are the contents and examples presented in a self-explanatory way?				
(2) User-centered learning				
2.1) Does it promote user empowerment and engagement through user-centered approaches such as self-assessment, self-regulation, reminder of past experiences and relationship to course content, project-based learning?				
2.2) Does it include the identification of the target audience, their main characteristics and learning needs? Is this information used to promote design adaptations, such as content / content setting?				
2.3) Are the learning pathways flexible and can the student choose which content and activities will be performed?				
2.4) Can the student take the course at his / her own pace and the delivery dates of the activities are flexible?				
2.5) It contemplates a greater number of formative evaluations than summative ones. Are alternative evaluation methods also used and privileged, such as initial and final diagnostic evaluation?				
(3) Self-Regulation learning				
3.1) Does it include suggestions on how the student can create a learning plan, set learning goals and a timetable for acquiring knowledge and developing the desired skills?				
3.2) Does it provide rewards (bonuses, points, gifts) for students who fulfill certain tasks?				
3.3) Does it include clear guidelines on syllabus, schedule, assessments, criteria and course tasks, among other items?				
3.4) Is the course well structured, that is, are there clear directions of what the student should do? Navigation is transparent and easy to understand? Units and content are organized consistently?				
(4) Social Networking and Collaborative Learning				
4.1) Does it support cooperative rather than individual learning, for example, group or team activities, discussion forum, peer evaluation, space for information exchange, content and ideas?				
4.2) Does the project consider the use of a space and tools to promote social interaction, support and frequent contact among participants, such as hashtags, groups, lists, etc?				
4.3) Does it provide opportunities that allow the creation of small groups or subgroups of discussion and exchanges				

	based on common interests, culture, geography, language, etc.?				
4.4)	Netiquette guidance is contemplated ?				
	(5) Deep Learning, knowledge creation and sharing				
5.1)	Does it include activities that stimulate the development of higher level thinking skills (Bloom Taxonomy), such as drawing, building, programming, critiquing, experimenting, moderating, comparing, organizing, etc.?				
5.2)	Does it include activities that encourage students to use digital technologies to create and share their own content (blog, videos, texts, etc.)?				
5.3)	Does it contemplate actions that encourage participants to continue discussions and learning even after the end of the course, so that they can act as agents of transformation in their own contexts?				
	(6) Assessment and Understanding				
6.1)	Does it use self-assessments based on clear objectives and criteria by using rubrics or scales so the students can evaluate their performance and knowledge?				
6.2)	Does it use self-graded activities based on well-defined rubrics that stimulate students to further reflection and to help them verify their understanding of the activity or content?				
6.3)	Does it make use of peer review based on clear objectives and criteria using rubrics or scales?				
6.4)	Are the evaluations authentic, that is, are they based on real contexts and scenarios?				
6.5)	Are the proposed activities more divergent than convergent? That is, most of the questions can be answered in various ways and considering several options?				
6.6)	Does it include certificate for those who have successfully completed the course? Does this include defining the course success requirements?				
6.7)	Does the project require the use of quizzes or simple internal questions that need to be answered before continuing the course?				
	(7) Accommodate differences				
7.1)	Is the course designed to accommodate a greatest number of differences, e.g. individuals with different backgrounds, previous experiences, learning objectives and disabilities?				
7.2)	Does the project contemplate individuals from different cultures, countries, languages?				
7.3)	Are previous experiences of the students with the content used or remembered during the course?				
7.4)	Does the project offer learners a variety of media to capture and retain their attention, such as videos, texts, e-books, movies, games, simulators, and more?				
	(8) Feedback				
8.1)	Does the project consider that students will receive feedback from instructors, colleagues and automatic (from the system)?				
8.2)	Does the project include the sending of periodic e-mails to students, such as: welcome messages, filling in specific questionnaires, more detailed explanations about some complex activity, etc.?				
8.3)	Do instructors and tutors access the discussion forums in order to explain specific questions about the course (technical and pedagogical)?				

ICMC USP
SÃO CARLOS