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LEARNING DESIGN OF A PROGRAMMING AND ROBOTICS MOOC FOR CHILDHOOD TEACHERS AND EDUCATORS

DISEÑO DE APRENDIZAJE DE UN MOOC DE PROGRAMACIÓN Y ROBÓTICA PARA PROFESORES/AS Y EDUCADORES/AS DE INFANTIL

António Quintas-Mendes / antonio.mendes@uab.pt

LE@D, Universidade Aberta (UAb), Lisboa, Portugal

Elizabeth Batista de Souza / bethbatistasouza@gmail.com

LE@D, Universidade Aberta (UAb), Lisboa, Portugal

Lúcia Amante / lucia.amante@uab.pt

LE@D, Universidade Aberta (UAb), Lisboa, Portugal

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ABSTRACT

In early childhood, the curricular integration of computational thinking, programming, and robotics topics is ever more pressing. Therefore, preparing teachers and educators to implement this integration in the curriculum is fundamental. In the project «Laboratory of Technologies and Learning of Programming and Robotics in basic and pre-school education in Portugal», the proposal of a MOOC was designed to meet this demand. This paper discusses aspects of the architecture of MOOCs, and their typologies, in the context of the challenges that the researchers encountered in the design process of the present MOOC. To do so, the Interaction Equivalency Theorem was considered, which equates the fundamental types of interaction to be considered in course design (learner-instructor; learner-content; learner-learner). Considering that learning design is both a process and a product the design of the MOOC is analysed in terms of its socio-technical context and systemic tensions present in work-based learning. Through a qualitative analysis of an individual interview and of a focus group, the paper describes formal and informal interactions and attempts to define a common vision, consensus, and divergences and contradictions that are part of the learning design process. Finally, the MOOC is presented, and its pedagogical design is substantiated.

KEYWORDS

MOOCs; Learning design; Teacher training; Interaction Equivalency Theorem; Work-based learning; Computational thinking; Programming; Robotics.

RESUMEN

En la primera infancia, la integración curricular del pensamiento computacional, la programación y la robótica es cada vez más urgente, y es esencial preparar a los profesores y educadores para aplicarla. En el proyecto "Laboratório de Tecnologias e Aprendizagem de Programação e Robótica no Ensino Primário e Pré-Escolar em Portugal", se diseñó un MOOC para responder a esta demanda. Este artículo analiza aspectos de la arquitectura de los MOOC y sus tipologías, en el contexto de los retos encontrados durante el diseño de este MOOC. Se tuvo en cuenta el Teorema de la Equivalencia de la Interacción, que considera los tipos de interacción que deben tenerse en cuenta al diseñar un curso (alumno-instructor; alumno-contenido; alumno-aprendizaje). Considerando que el diseño del aprendizaje es tanto un proceso como un producto, el diseño de los MOOC se analiza en función de su contexto sociotécnico y de las tensiones sistémicas del aprendizaje en contexto de trabajo. Mediante el análisis cualitativo de una entrevista individual y de un grupo de discusión, se describen las interacciones y se intenta definir una visión común, las divergencias y las contradicciones que forman parte del proceso de aprendizaje. Por último, se presenta el MOOC y se fundamenta su diseño pedagógico.

PALABRAS CLAVE

MOOCs; Diseño de aprendizaje; Formación del profesorado; Teorema de equivalencia de la interacción; Aprendizaje basado en el trabajo; Pensamiento computacional; Programación; Robótica.

1. INTRODUCTION

Current society increasingly demands critical thinking and the use of technologies to solve everyday problems. In this sense, the curricular integration of topics such as computational thinking, programming, and robotics, in early childhood, is ever more pressing. Therefore, preparing teachers and educators to implement this integration is fundamental. In the context of the project «Laboratory of Technologies and Learning of Programming and Robotics in basic and pre-school education in Portugal», the proposal of a MOOC on Programming and Robotics was designed to meet this demand. This paper discusses the development of the MOOC in the context of the project, describing its various contingencies in the process of its development. It presents a synthesis of the evaluation of the blended learning training developed with teachers/educators on computational thinking, programming, and robotics, as well as some results of the study that identifies the training needs of kindergarten teachers and educators in the introduction of programming and robotics. Then it describes the process of development of the MOOC.

The theoretical perspective adopted in this work includes 3 dimensions: 1) the theoretical-pedagogical models about MOOCs and their typologies that allow making this or that option about the type of MOOC to develop; 2) the Interaction Equivalency Theorem that allows thinking in detail about which types of interaction should be privileged in the design of a MOOC (Teacher-Student Interaction, Student-Content Interaction, and the Student-Student Interaction) and 3) the "work-based learning" models that allow thinking about the work of the various actors involved in the production of a MOOC from the socio-technical context that supports and contextualizes all the pedagogical production taking into account two fundamental sub-systems: the technical sub-system and the social sub-system. After the general framework of the project and the theoretical framework are considered, it is described the data collection methodology adopted to characterize the MOOC design process as it was experienced by the team, and attempts are made, through the voice of various participants, to identify beliefs, expectations, experiences, constraints, and decisions that allow for an understanding of many of the options taken.

1.1. THE KML II PROJECT AS A CONTEXT FOR THE DEVELOPMENT OF A MOOC

The discussion that we bring in this article related to the design of the architecture of a MOOC on programming and robotics, its constraints, and challenges, is part of the project "KML II - Laboratory of technologies and learning of programming and robotics for preschool and primary schools". This project originated in the Kids Media Lab (Miranda-Pinto & Osório, 2015) whose main research question aimed to understand how children learn to program at preschool age while seeking to promote the learning of programming and robotics in formal and informal learning environments at these ages. This project evolved, extending to other educational levels, and gave rise to the current KML II project, which aimed to develop and deepen another aspect, that of training, in response to the need to empower teachers to use programming and robotics as a means of learning, both in pre-school education and in the 1st cycle of basic education, as well as to study how to effectively integrate them in these contexts (Miranda *et al.*, 2017). Indeed, recognizing the importance of computational thinking (EC, 2016; Bers, 2018; UNESCO, 2018) for the promotion of critical thinking and participatory digital citizenship that allows children to

develop multiple transversal skills, it is important to prepare teachers in this domain, namely, to plan the integration of computational thinking in initial training curricula.

Thus, we intended to develop a training process at the national level, followed by the development of several case studies aiming to outline the profile of the early childhood educator and primary school teacher as mediators in the integration of programming and robotics in educational contexts. At the same time, the training needs in technology, programming, and robotics of these professional groups were assessed in an attempt to contribute to the definition of a curriculum structure in initial teacher training that includes the integration of these topics (Monteiro, *et al*. 2019). Finally, the design and development of a MOOC is a final product of the project that aims to expand the access of teachers in the Portuguese education network to the strategies and resources to be used in computational thinking, programming, and robotics activities to be developed with children.

The project's coordinating group is integrated into CIEd (University of Minho) and includes several partner institutions. Among them is a team from the Distance and Elearning Education Laboratory (LE@D) of the Portuguese Open University (UAb), which took responsibility for the design, provision, management, and evaluation of the virtual training environments assigned to the project (Amante, Souza & Quintas-Mendes, 2019). The set of data collected under this activity, namely the results of the trainees' satisfaction assessment with the blended learning course implemented (Souza; Amante & Quintas-Mendes, 2020), provided important inputs to the project team intending to make decisions regarding the design of the course in MOOC format which is the focus of this article.

1.2. THE B-LEARNING TRAINING DEVELOPED DURING KML II AND ITS EVALUATION

The training, "Computational thinking, programming, and robotics in basic education" was carried out in a b-learning format and had a duration of 50 hours (25 hours of presence and 25 hours of distance activities) and used the Moodle platform as the Virtual Learning Environment (VLE). The choice of blended learning modality was based on the assumption of being able to simultaneously collect, and in an eclectic way, the advantages of face-to-face interaction and the advantages of mediated education, namely online communication. Thus, the blended learning solution sought to benefit from the strengths of each of the teaching modalities and, simultaneously, circumvent the weaknesses of any of them (Osguthorpe & Graham, 2003).

A total of 114 teachers participated in the training, distributed in eight classes, according to the geographical location of the poles of the institutions participating in the project. It was organized into a total of 11 learning sessions (five face-to-face and six distance learning), divided into three modules: Computational Thinking, Educational Robotics, and Programming.

For each module, the learning sessions' scripts, the resources to be explored, the activities for autonomous work, and a forum for discussion of the specific theme were made available in the VLE. The face-to-face sessions were held on each pole and coordinated by expert trainers from each of the project's partner institutions. These moments were devoted to group activities, the discussion of the specific themes of each module, and, in particular, the handling of equipment, namely in the Educational Robotics module where it was possible to handle the various models provided by the project team. The online sessions included synchronous and asynchronous mo-

ments. The synchronous moments were held in videoconference format and their main objective was to introduce new topics, explain autonomous activities and clarify doubts since they allowed interaction with the lecturer in real time. These synchronous moments occurred simultaneously for all classes and were always recorded, allowing everyone to review or watch those sessions later. Asynchronous communication took place in the VLE, mainly through thematic forums and doubt forums.

The evaluation of the training was carried out through a final questionnaire, of 25 closed-ended items, and 3 open-ended questions, divided into five dimensions: Characterisation of the respondents, Satisfaction with the training (pedagogical strategies, training environments, resources, trainers, training format) Perception on learning and involvement in the training, Perception on the practical application of the training and Criticisms and suggestions for improvement.

The results allowed us, among other things, to identify the profile of the potential target audience of the MOOC to be developed as a product of the project.

Thus, in this course, more than 80% were women over 40 years old, and within these, half were over 50 years old, in line with the majority profile of teachers working in Portugal (MEC-PT, 2019). The vast majority were born before the advent of the Internet and about half of the participants had no previous experience in attending distance learning courses. They also had no training experience in the specific theme of computational thinking, programming, and robotics, although 50% of the participants indicated having had classroom experience in at least one of the themes of the course.

A very good level of general satisfaction with the training was registered, except for the item "evaluation process", which obtained lower levels of satisfaction justified by the absence of feedback on the works delivered in the VLE. The satisfaction with the technical and pedagogical team was the highest of the set, both in the face-to-face meetings and in the distance sessions, with the item "mediation and interaction with trainees" being particularly valued and the items related to the duration and schedule of the synchronous sessions being less valued.

Regarding the b-learning format of the training, approximately 30% of the participants would have liked the training to include more face-to-face time. The open-ended questions revealed that the face-to-face sessions were considered more effective in terms of experimentation and learning, especially in the topic of educational robotics, whose activities required the manipulation of robots.

The perception of participation and involvement showed a high index, a large majority of respondents revealed a good motivational level for the completion of the training and approximately 2/3 indicated that it was easy to meet the objectives.

In summary, based on these data and the analysis of the communicational dynamics established in the VLE, namely in the thematic forums, we can conclude that, although the b-learning format of the training proved to be adequate to the immediate training needs, the learning and interaction potential of the distance learning moments was underused compared to what the VLE interface allowed. The team of trainers, usually acting in face-to-face contexts, placed great emphasis on the interaction that took place in the face-to-face meetings and did not act so actively in the interactions that could potentially occur in the forums.

Regarding the design of the activities, two points should be carefully observed: volume and format. Considering the time of training and the profile of the target audience, it should be taken into account that a very large volume of activities is not advisable. Regarding the format, it is considered necessary to invest in more collaborative activities which, even if carried out individually, may be shared and commented on by peers, making the learning process less solitary and richer.

As far as evaluation is concerned, and particularly in the scarcity of feedback from trainers, the adoption of self-assessment and peer evaluation mechanisms may contribute to a higher level of interaction among participants and thus to better feedback processes.

1.3. IDENTIFYING TEACHER TRAINING NEEDS IN PORTUGAL

Within the scope of the project, a study was conducted by one of its partners, which involved the construction and application of a nationwide survey to assess the training needs of early childhood educators and teachers in the field of programming and robotics (Ramos, 2022). This study revealed, among many other aspects, that a large majority of educators/teachers pointed out the lack of adequate training offered to meet their needs as one of the main obstacles to training in the field of programming, robotics, and computational thinking. At the same time, it showed a critical position towards training formats that do not take into account the specificity of the contexts in which teachers and educators work and their different local realities. The study also shows that the follow-up of teachers should not end with the completion of the training action, considering it necessary to maintain continuous support to help implement the new practices and concepts targeted in the professional development programs.

Thus, even though most of the respondents prefer face-to-face training or training with face-to-face components, it is also true that the availability of a MOOC course may not only meet the training needs identified in this area but may also contribute to overcoming some of the criticisms pointed out to other training formats. In effect, a MOOC may lead to the development of learning communities that last beyond the space and time of the training. However, for this training modality to be successful it is also important to consider other factors such as the diversity/heterogeneity of the target audience and its specific contexts of action. Thus, it is important to consider the need for the course to be structured considering differentiated and flexible training itineraries that meet the specificities in question (level of education, digital skills, among others) and, if possible, to be inserted in a broader and less punctual training program, enhancing its effectiveness.

1.4. MASSIVE OPEN ONLINE COURSE AND TEACHER TRAINING

The term MOOC was coined in 2008 by Dave Cormier and Bryan Alexander. Massive Open Online Courses (MOOCs) are characterized, as the name implies, as a form of mass distribution of online learning that falls within the scope of Open and Distance Education.

The MOOCs are products of the open learning movements and the dissemination of Web 2.0, which significantly changed the way people interact on networks, no longer having an attitude only toward consumers, but also starting to produce their content. At the same time the Open Educational Resources (OER) movement, a term that emerged in an educational forum promoted

by UNESCO in 2002, allowed to expand the democratic access to knowledge, with rationalized expenses, contributing to a new ecology of knowledge (Litto, 2006).

George Siemens and Stephen Downes, creators of a learning theory for the digital age, consider that Connectivism differs from previous theories in that it takes into account how technology influences the ways of communicating and learning (Siemens, 2005), ended up facing the challenge of expanding on a large scale the model designed by them. And so, in 2008, the first course using the acronym MOOC was created. In this first MOOC, 2,200 people participated and it was called "Connectivism and Connectivist Knowledge".

MOOCs are online courses open, free, and offered to a large number of people. In general, they have no prerequisites for entry and no requirement for formal certification (Mcauley *et al.*, 2010; Brouns *et al.*, 2014; Teixeira *et al.*, 2019).

Gonçalves *et al.* (2015) state that, despite the informality characteristic of MOOCs, they can be used as a complementary way in the teaching and learning process, because this offer provides the necessary conditions to democratize access to information and also equity in knowledge, not neglecting the quality and pedagogical aspects of the educational offer. The authors also state that "as long as the teachers' digital skills are guaranteed, as well as the access to technologies and the suitability of contents and activities, the MOOCs can be a valid strategy at the e-learning level" (p. 6). According to Lambert (2020), MOOCs offer a new range of possibilities to expand access to and participation in quality education, thus promoting more equitable, open and socially inclusive learning environments.

Based on the first experience of this course format, carried out by Siemens and Downes, many other initiatives have been carried out and MOOCs seem to have gained a place among the courses offered online, with the differential of being potentially more prepared to reach large audiences.

At least two types of MOOCs can be identified, with the main differences related to learning theories and types of licensing of the resources made available. In Table 1, below, we characterize each of these two types of MOOC:

Table 1: cMOOC and xMOOC characteristics

cMOOC	xMOOC
Fundamentally based on Connectivism: • Focus on peer activities and interaction. • Each participant is a potential teacher. • Collaborative work. • Peer assessment. • Explore more the connections between participants.	Based on more traditional models of learning: • The teacher is the authority. • Information organized by topics. • Recorded courses. • Evaluation carried out by the teacher.
Open resources: • Created by the participants. • Open licensing.	Resources with private intellectual property: • Created by teachers and organizations.
Open/flexible goals are defined together with the participants.	Pre-defined goals in course design.

Source: Elaborated by the author

Many of the criticisms of this format of educational offer are related both to extrinsic aspects, such as the comparison with the quality of face-to-face offers; and to intrinsic aspects, which question the quality of pedagogical strategies, the variety of the level of demand, difficulties regarding copyright, quality of the content offered, the potential for effective inclusion and economic potential. Still, an expansion of this type of offer is observed in recent years, especially with the creation of platforms that have specialized in this type of course.

For teacher training, there is a growing challenge to design and make available training offers that fit into continuous training programs, given the need to prepare teachers to respond to the numerous challenges that arise daily in these connected times. MOOCs, despite any identified constraints, appears to be a format of educational offering that makes access to study possible for anyone whose circumstances make traditional learning difficult or impossible (Read & Barcena, 2019; Laurillard, 2017; Gonçalves *et al.*, 2015).

However, as Gonçalves *et al.* (2015) states,

> *It cannot be stated that continuing teacher education will come to be delivered through this modality, but it is notable that MOOCs can be a suitable model, not only for different types of training but also for diverse groups of recipients.* (p. 9)

In agreement with Guàrdia, Maina, and Sangrà (2013), it is understood that discussions around MOOCs focus essentially on strategic, institutional, economic, social, and technological concerns. The more in-depth pedagogical debate is left in the background.

Some participants in MOOCs may be more motivated by the information available and not so much by the curriculum or the certification in the course and the instructional design should take

this into account, designing space both for those who come for the pure pursuit of knowledge and also for those who, for example, want to deepen their learning in the framework of their professional development and skills acquisition (Scagnoli, 2012; De Barba, Kennedy & Ainley, 2016). Starting from the assumption that participants in a MOOC should benefit from the knowledge of an expert, but also need to feel contemplated and empowered to share their knowledge within a learning community, Scagnoli (2012) proposes five elements to be considered in the design of a MOOC, relating them to some activities that favour them: Previous experience (remembering past experiences with videos, case studies, and other resources); New Learning (input from videos, readings and other multimedia); Understanding (diagnosing comprehension with quizzes and tests); Engagement (Forums, Peer Assessment) and Legacy (interactions in social media).

Therefore, we realize that the great challenge in the design of a MOOC lies in contemplating elements that appeal to the different profiles of participants, who despite the interest that unites them around the theme, differ greatly about the motivation to engage in a particular training, hence the importance of ensuring the elements proposed above, helping to prepare to meet the diversity of participants, allowing the creation of an environment that inspires and intellectually challenges all profiles.

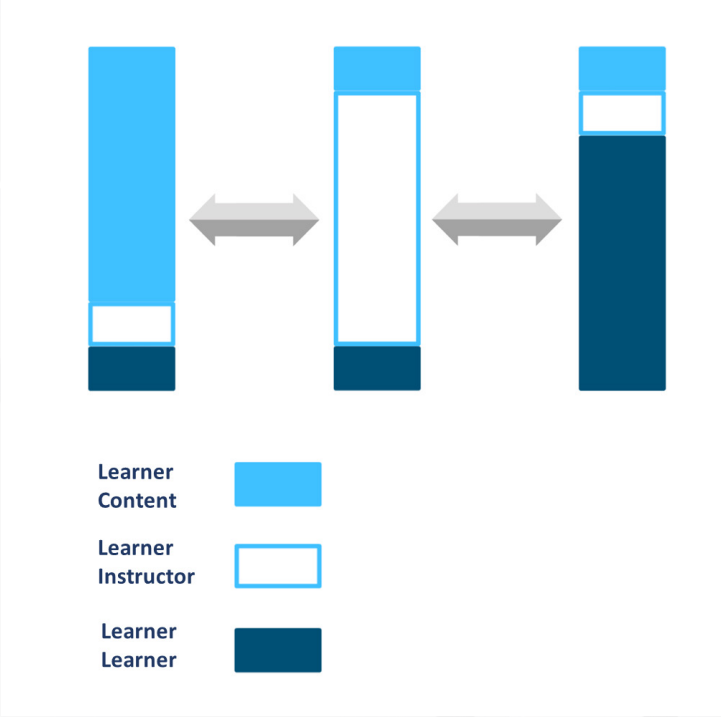
1.5. THEORIES OF ONLINE INTERACTION: THE INTERACTION EQUIVALENCY THEOREM

Besides having introduced the important concept of Transactional Distance, Michael Moore (1989) elaborated on the distinction between three types of interaction: student-teacher, student-content, and student-student. Anderson and Garrison (1998) added to this model other three types of interaction: teacher-teacher; teacher-content and content-content.

Given this set of interaction possibilities, it may be interesting to think of all these configurations as options, as possibilities or degrees of freedom that the teacher, the trainer, or the designer of a course have at their disposal as conceptual tools to think about its design. Precisely based on this range of possibilities Anderson (2003), in his article "Getting the mix right", enunciated for the first time a model, which he called "Interaction Equivalence Theorem" (EQuiv), a model he later expanded to MOOCs and Open Educational Resources (Miyazoe & Anderson (2013). The EQuiv formulation essentially argues for two theses:

Thesis 1: Deep and meaningful learning is possible as long as one of the three forms of interaction (student-teacher; student-student; student-content) is of a high level. The other two forms of interaction can be offered at minimal levels, or even eliminated, without degrading the educational experience (Figure 1).

Figure 1: Thesis 1 - Variations of the intensity of interaction in the three types of courses

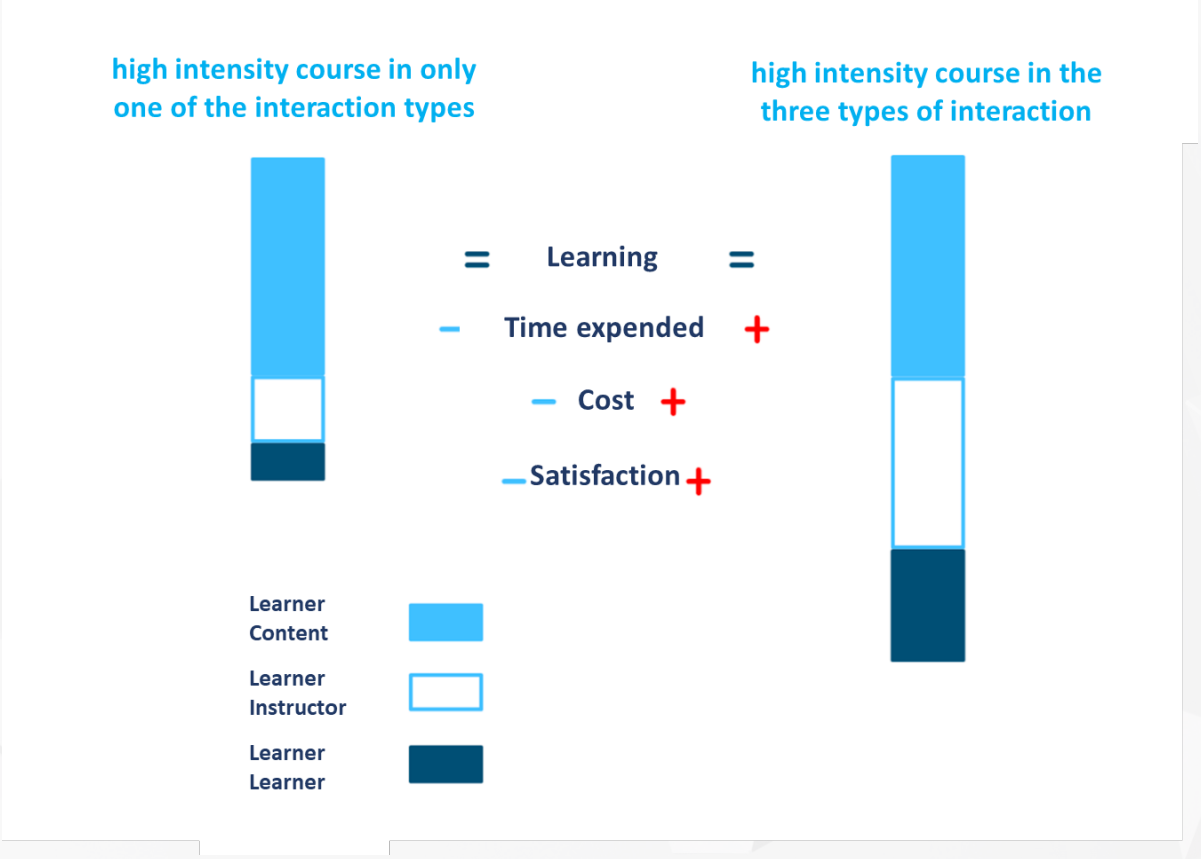


Source: Quintas-Mendes *et al.* (2019, p. 59)

In Figure 1 we can see, on the left, the case where student-content interaction predominates over the other two forms of interaction; in the centre, we find the case where teacher-student interaction has a much higher intensity than either student-content or student-student interaction and on the right the case where the latter form of interaction has a much higher intensity than either teacher-student or student-content interaction.

Thesis 2: Very high levels in more than one of the three types of interaction will promote greater satisfaction in the educational experience, but not necessarily more efficient learning, although they imply greater cost and time expenditure. As examples of this second thesis, we can observe in Figure 2, the representation of two courses with different levels of intensity. On the left is represented a course with high intensity in only one of the interaction types, leading to lower expenditure, less time spent, and eventually lower satisfaction, while on the right, we observe the representation of a course with high intensity in all three interaction types, consequently having more costs, more time spent and eventually higher student satisfaction, than the previous course. However, the quality of learning is hypothetically the same in both courses (Figure 2).

Figure 2: Examples of courses with different levels of interaction



Source: Quintas-Mendes *et al.* (2019, p. 60)

The usefulness of this model is that we can vary the intensity of each of the elements present in a course according to the available resources. We can think, for example, of a course more directed towards self-learning when we have an abundance of available content but we do not have human resources (teachers or tutors) qualified for the moderation of an online course; or, on the contrary, we may not have elaborated contents nor financial resources to invest in contents but we have qualified personnel to develop a course very much based on the dialogue and the conversation between students and teachers. Or still, the third hypothesis, we may not have many resources for one or the other, but we have possibilities to promote with enough intensity the interaction student-student or trainee-trainee, taking advantage of the capital of experience of these, which may contribute to a course rich in collaboration and sharing of experiences. In this way, the EQuiv can emerge as a central element in the instructional design and in supporting the decisions that the actors involved in course development have to make (Cabral & Quintas-Mendes, 2018; Quintas-Mendes; Wyszomirska & Cabral, 2019). In order to increase the efficiency of costs and time, we can focus on only one of the nodes of the interaction. However, we can develop designs that have some flexibility, adjusting that design to each situation. For example, in the case of an online course, we can have a design essentially centred on the student-content interaction, but that at a given moment incorporates a synchronous videoconference with the teacher, and then switch then to interaction more centred on the student-teacher node.

In the case of MOOCs, we can say that connectivist MOOCs or cMOOCs are more centred on student-student interaction while more self-instructional MOOCs or xMOOCs are more centred

on student-content interaction. In the middle of this spectrum, we can see that a lot of possibilities may emerge and choices about those possibilities constitute a great part of the work in the learning design process (Borup *et al*. 2022).

1.6. THE SOCIOTECHNICAL CONTEXT OF THE DEVELOPMENT OF A MOOC

Learning design is both a process and a product. Learning Design as a process is what teachers, learning designers, and other professionals do, while learning design as a product is what they produce as the outcome of this process (Masterman, 2009; Donald *et al*. 2017). Several authors have stressed the importance of investigating the contexts and modes of production of pedagogical offers from the consideration of the socio-technical infrastructures that support and contextualise them (Bielaczyc, 2006; Guribye, 2015; Sannino; Engestrom, Lemos, 2016). As Drake and Seeman (2015) state:

> *Higher Education can be viewed as a socio-technical system (STS) (...). Every organisation can be thought of as having two sub-systems: the social and the technical. The social system comprises people and structure; the technical system comprises technology and task. Attributes of people (such as their attitudes, skills, and values), as well as reward and authority structures, are among the concerns of the social system, while the technology that drives task accomplishment are the concerns of the technical system.* (p. 129)

Freire (2020; 2021) draws attention to the need to bridge a certain gap in the literature regarding research on the socio-technical skills and organisational structures required for the process of developing a MOOC in the framework of work-based learning experiences. This is particularly relevant in a multidisciplinary work context that involves professionals from diverse backgrounds, profiles, and specialities. Freire (2020;2021) bases his work on models of «workplace learning» (Marsick and Watkins, 2003) and on the «Activity Theory» with its origins in the work of Vygotsky Leontiev and more recently in the work of Sannino, Engeström and Lemos (Sannino, Engeström & Lemos, 2016). In Marsick and Watkins's work (2003) the importance of the study of learning in organisations is underlined, as well as the importance of work-based learning in which informal learning and incidental learning take particular relevance and which is particularly relevant in the case of the development of a MOOC that involves the participation of several multidisciplinary teams belonging to different organisations.

According to Freire (2020; 2021) in the literature on work-based learning one can distinguish between Labor Related Learning originating as a by-product of formal and informal activities (e-g. meetings, training, counselling, virtual learning communities) and Labor Integrated Learning derived from production, as a by-product of job activities (e.g., organizational culture, trial-and-error experimentation, task accomplishment).

For Marsick and Watkins (2003) the most relevant dimensions of work-based learning are: the need to create continuous learning opportunities and the promotion of dialogue so that people express their opinions and develop the ability to listen and enquire about the opinions of others, thus creating a culture that supports questioning, feedback and experimentation; collaboration and team learning encouragement so that work is designed in a way that groups can access different ways of thinking and in a way that groups can learn and work together making collaboration valued. Of particular importance is still the empowerment of people to create a common

collective vision. Actors are involved in defining and implementing a joint vision for a project or an activity. Responsibility is distributed in a way that enables decision-making so that they are motivated to learn and carry out what they have to do. As Watkins (2017) puts it:

> *A culture of learning cannot be created with a training session but occurs in the "karma in the walls and halls" (...) in the daily interactions between individuals at work, between leaders and followers. Informal learning consists of all the non-classroom-based learning activities individuals engage in to acquire the knowledge they need to do their work. As such, this learning is ubiquitous.* (p. 219)

It is precisely these movements of formal and informal interactions, of attempts to define a common vision, of consensus but also of divergences and contradictions that are part of the learning design as both process and product that we will try to describe in this paper.

2. DESIGN AND METHOD

The research was conducted using a qualitative, non-experimental, and descriptive design (Creswell, 2014). A qualitative design was selected because it was assumed that the aim is to describe and interpret reality and seek to transform this reality by accumulating experience from listening and characterising a plurality of voices that express the experiences and perceptions of the real protagonists of the work involved in the process of designing a MOOC in a way that can be useful for the community.

In order to analyse the challenges that the various actors intervening in the development of a MOOC encounter in the process of defining the MOOC design, qualitative methodologies were used based on a) document analysis of the various products that were produced throughout the development of the project; b) recording of work meetings of the project development team; c) conducting a focus group with the team responsible for the development of the MOOC and with the person in charge of the KML II Project and d) conducting an individual semi-structured interview with the instructional designer responsible for the MOOC design. In this paper we will essentially analyse the data obtained in c) and d).

3. FIELDWORK AND DATA ANALYSIS

Both the individual interview and the Focus Group were carried out by web conference, through Zoom. The recordings were transcribed with the help of the software Transkcriptor and later reviewed by the three authors. The transcripts were then anonymized and treated in terms of thematic analysis using NVivo software.

The interview script was similar for both the Focus Group and the individual interview. The questions focused on the following aspects: Project management; Resources; Technologies; Interaction with content experts; Content development; Pedagogical foundations of the MOOC and the aims and objectives of the MOOC.

4. RESULTS

When we compare the prevalent themes in the individual interview and the prevalent themes in the Focus Group, we see that some themes are clearly prevalent in the Focus Group while other themes are prevalent in the individual interview with the Instructional Designer. In the latter, the themes concerning the pedagogical foundations of the MOOC are prevalent in relation to the themes emerging in the Focus Group, except for the MOOC purposes and aims, a theme more evident in the Focus Group than in the individual interview to the Instructional Designer which can be understood by the fact that this category implies a greater assumption of a common vision by the collective. Themes related to Content Development, Resources, and Interaction with Content Experts were more prevalent in the Focus Group. And some themes such as "Work-Based Learning", "Building a Common Vision" and issues related to "Face to Face versus Online Distance Education" appear with a similar percentage coverage both in the individual interview with the Instructional Designer and in the Focus Group.

All participants reported work-based learning experiences and systemic tensions related to the diverse phases of the MOOC design cycle. Systemic constraints appear in generic and common themes that reflect the scarcity of resources: financial resources; time resources and qualified human resources with the necessary expertise to work in a MOOC for the first time.

All participants also report that a factor that had a major impact on the work process, design, and implementation of the MOOC was the disruption of the project schedule, caused by the Covid19 pandemic. The MOOC that was initially planned to be finalised and implemented during the last year of the project KML II actually will be implemented only after the completion of the project.

Due to the large number of topics that emerged during the interviews, we will only detail in the data and results analysis some topics that seem to us of particular interest. These topics are related to 1) the establishment of a common vision regarding the aims of the MOOC; 2) the socio-technical issues posed at the level of instructional design when facing new technological challenges; 3) the disruption caused in many content specialists by the process of development of a MOOC due to the fact that those specialists are mainly used to face-to-face education, and 4) the discussion of the pedagogical philosophy in which the MOOC should be based.

4.1. AIMS OF THE MOOC: SOME DIFFICULTIES RELATED TO BUILDING A COMMON VISION

For Marsick and Watkins (2003) one of the fundamental components of learning in a work context is the building of a common vision. This dimension simultaneously includes discussions and agreements, consensus and conflicts, periods of indecision, and moments of decision-making. In the data collected, the problem of the construction of a common vision becomes particularly evident when addressing the themes of the MOOC aims and goals or the pedagogical philosophy of the MOOC. It should be said that the idea of developing a MOOC at the end of the KML II Project was perfectly defined at the outset. In the words of Maria in the Focus Group:

> *the initial idea of the MOOC appears already as being a product in the project application. When we applied for the project, we had already thought that at the end there*

> *would be a training for all (...) there would have to be a product and a product would be a MOOC (...) this did not come about after the project had started. (...) We could not train everyone in the country and when we designed the project the idea of the MOOC was already included in it so that we could make the same training contents available to people who did not have the opportunity to participate in either the project or the Kids Media Lab project or the KML II project, i.e. it was a way of giving the same knowledge to those who never had the opportunity to participate in either one.*

Despite this goal being established from the beginning, it does not seem to have been totally integrated by the various working groups. In the individual interview, Beatriz, the instructional designer, says:

> *The MOOC for me at the beginning was an unknown factor, I think it was like that for everyone, and it was like this: it is a kind of product, that comes later in the global project.... we thought that we would make use of much of what was used in the blended learning course and that this would not be a problem.*

Referring to the content specialists, Maria says in the Focus group:

> *I think they have a lot of difficulties because initially there was even some resistance (...) I think there has been a lot of resistance to completing the MOOC precisely because I think they have not yet understood the value that this could come to have, really the interest that this could have for people at the national level.*

Doubts, resistance, and questioning then begin to arise partly due to certain disbelief in the MOOC format as a good format for teacher training:

> *BEATRIZ: They didn't say it with those words, but by the way that this team behaved concerning every time we were going to present the design, they never discussed the design, and they were always discussing this objective "I don't know if this is really the objective". It seems to me that it was very much in disbelief that this is going to have any value in terms of fulfilling this objective, do you understand? I think they think that that goal is not feasible.*

The instructional designer considers that these resistances impacted a lot on the development of the MOOC design because there were many meetings where indecision or resistance predominated:

> *BEATRIZ: People kept running around and at each meeting, someone new appeared who had* not participated in the previous one and came back to question. I remember once, I don't know, the tenth meeting in which someone came to question the goal of the MOOC, which we had already discussed a lot and was already mature, at least for that previous group (...) But so, at each meeting, it did not advance and we could not start producing because no one said OK, let's go ahead, they always discussed minor details, but not necessarily the design. Nobody proposed anything different, look. Nobody would say, look, this is not good, we wanted this, they didn't. Sometimes they got caught up in the details or the objective.

In order to overcome these impasses, leadership problems naturally arise, which the instructional designer alludes to in this excerpt:

> *BEATRIZ: We were in a defence of our ideas and Luísa was very active on that, right? She helped a lot in this defence. To ensure some characteristics of this MOOC.*

It is also interesting to note that some factors external to the project helped to unblock situations and make the necessary decisions. Maria points out on the one hand the external demand from teachers and on the other hand the possibilities that opened up regarding the accreditation of the MOOC by the Ministry of Education:

> *MARIA: many people are already asking me if the MOOC is really going to be launched because I think that many people are interested in this. Even some things that were difficult for us two years ago I think were unthinkable, for example, having a MOOC accredited by the pedagogical council, right? To give credits and for people to be more motivated to do this type of training, isn't it?*

This type of external pressure was thus contributing to the unblocking of some situations and to better integration and acceptance of the aims of the MOOC, which were defined at the outset as being oriented towards a training process and dissemination of knowledge at a national level.

4.2. FACING NEW TECHNOLOGICAL CHALLENGES

At a certain point in the project, it was decided to start doing the MOOC not in the Moodle of one of the universities but in the NAU platform[1]. This decision didn`t correspond to the initial project but it arose in a context of opportunity that it was decided to take advantage of because on the one hand it allowed to reach a wider audience and on the other hand it saved time for the team that would be responsible for implementing the MOOC in Moodle.

MARIA: the idea of the NAU platform was to integrate a platform that had a relationship with the Ministry of Education. Why was that? Because the idea was always that this project would somehow have visibility in schools. And to reach schools much more easily through the DGE, the Directorate General of Education.

Of course, taking advantage of this opportunity also implied integration with other teams, namely regarding training processes on the new platform, as well as a working relationship regarding the delivery of contents to these new partners, with some additional problems. In particular, the instructional designer had to be trained on the new platform and started to have to deal with other partners from whom she felt distant. With regard to the technological dimension Beatriz mentions:

when we idealised the first design of the MOOC there was the idea of implementation on the Moodle platform. And we already had all the know-how, the knowledge, the way to organize this design in Moodle, and when the idea of NAU came, so, if we hadn't had the training course for NAU, course producers, we would have had some difficulties (...) today I need more support from some technicians (...) they have the full expertise of that environment, right? So, we wanted to create two itineraries there. In Moodle, I would know exactly how to give the solution I already

[1] The NAU platform (https://www.nau.edu.pt) is a service developed and managed by the FCCN Unit of the Foundation for Science and Technology (FCT) that allows the creation of courses in MOOC format. In partnership with the Directorate General for Education / Ministry of Education, it is a platform specially created to support education and training for large audiences.

have this more internalized. In the case of NAU, we needed to consult experts to know what was the best solution.

From the social point of view, Beatriz points out the added difficulty of having to deal with a team from outside the project.

So, for me, this has been one of the biggest constraints in terms of the progress of the process because everything is very distant, not geographically but in terms of positioning in the project.

These constraints are both of a technical and social nature and are an excellent example of the simultaneously social and technical nature of instructional design, as highlighted by Drake and Seeman (2015).

4.3. THE INTERACTION WITH THE CONTENT SPECIALISTS FROM FACE-TO-FACE TRAINING TO VIRTUAL DISTANCE TRAINING: HESITATIONS AND RESISTANCES

The interaction of the MOOC development team with the content experts reveals some difficulties at different levels. One of these difficulties has to do with a certain lack of confidence in training in virtual environments. This is referred to by the developers of the blended course which took place during the KML II project, and which was characterised in the initial part of this paper. It was found that training ended up taking place essentially during face-to-face sessions. The Moodle platform ended up serving mainly as a repository of materials, with little online interaction between trainees and trainers. Luísa identifies some of the difficulties which occurred in the blended course, and which may impact how the content experts view their contribution to the MOOC:

> *the feeling we had, based on the evaluation we carried out, was that the trainers interacted very little online. So, in practice, they focused on the face-to-face sessions, and what happened online was not exactly relevant or valued (..) This I think is a sign that these trainers were very used to and focused on face-to-face work, despite working with technologies, right? But very formatted, let's say, for face-to-face training and not for distance training... and, therefore, maybe there is also some explanation for this resistance about the MOOC, right? On the one hand, distance learning had not gotten them particularly involved. So it is as if they also thought that that virtual space was there, but «what matters is when I will be with the students in person». And, in some way, maybe this is similar to what we see now about how they see the MOOC, I don't know.*

If this resistance existed in a blended course, greater resistance would be expected in a fully virtual course such as the MOOC. In this line, some of the content experts are perceived, by the MOOC development team, as having little confidence in the MOOC format for teacher training.

> *BEATRIZ: I think they are very competent to create things. I have seen several of them doing very interesting things (...) But so, basically, the team of X defends that the MOOC is not a good strategy for this type of delivery. I think this has become very internalized for them.*

It is important to underline that the content experts, although they are specialists in technologies in education, are in fact teachers in face-to-face universities and not used to online distance lear-

ning courses, which makes it sometimes difficult for them to think about how to develop content for a MOOC.

> *BEATRIZ: Maria even quoted one of them (...) she told me the other day, that one of them told her that she could not think of some activities that could be implemented at a distance, that all of them needed to be face-to-face.*

However, this mistrust towards distance learning is not transversal to all content experts. BEATRIZ mentions:

> *But not all experts are resistant. Those from the programming area, feel more comfortable developing content for distance learning courses.*

Another difficulty may be related to the very nature of the contents. Thus, in the Focus Group with the team responsible for the design of the MOOC, Manuel comments:

> *Not long ago I heard a robotics specialist say at a conference: «with this pandemic, we have interrupted the work on robotics and computational thinking because I think that at a distance this doesn't work». She claimed this, that's an opinion, isn't it? (...) but the paradox is that I think that on the one hand I perfectly understand this, given the materiality of the objects and the need to manipulate them, etc, but on the other hand, these people are the ones who in the future will be better positioned to, for example, work with remote laboratories which are precisely laboratories where we work with this type of mechanisms, machines, devices…*

However, Luisa countered that it is something independent of the contents:

> *It could be this robotics content, or it could be any other content. The thing is that people weren't aware of what to do online, how to promote the online discussion, the questioning, the sharing, the raising of other working hypotheses… this wasn't done, and I think this happens regardless of the topic that is being worked on, isn't it?*

Beatriz and Maria contrast this resistance to online training based on the nature of the contents with cases of trainees who showed enthusiasm towards this type of training and were able to maintain with their students, during the pandemic period, remote programming, and robotics activities:

> *BEATRIZ: that teacher who is called C., she is an enthusiast. I always remember her reports about her class, that during the beginning of the pandemic they managed to keep up and continue their work.*
>
> *MARIA: It is, and I can say that educator M. was also able to have the students at home with Scratch Junior and with robots because they already had them at home, and they were able to do some activities remotely. Yes, she was able to involve [the students].*

We can thus see that for the MOOC development team, the content experts' lack of experience as online trainers meant that on the one hand, they had doubts about the MOOC format as a useful format for teacher training and on the other hand they expressed doubts about the feasibility of producing content on programming and robotics to be used in a purely virtual context.

4.4. DISCUSSING THE PEDAGOGICAL PHILOSOPHY OF THE MOOC

As far as the initially foreseen MOOC Model the intention was to carry out a MOOC of a more connectivist nature (including the possibility of intervention of some more active tutoring) but, given the discussions that took place and the lack of resources (financial and human) it was decided to opt for an "intermediate solution".

In the interview with instructional designer Beatriz, it is very clear the distinction she draws between more active MOOCs and more passive MOOCs. A more passive MOOC is characterised by Beatriz as a MOOC very focused on the contents and on some quiz-type activities whose main function is to assess the trainees' retention of concepts. A more active MOOC is characterised as a MOOC that has, (besides the contents and some quizzes for feedback and self-assessment), activities and projects that are made visible through e-portfolios. For Beatriz, passive MOOCs have no "practice", i.e., they do not involve students in activities that turn trainees into producers and authors of their own content. The trainee is a mere receiver of questions that he/she must answer. Beatriz gives an example of one of these types of MOOCs in which she herself participated:

> *It was an interesting topic (learning in communities), but the MOOC was very simple, and the design was focused only on the content (...). There were five weeks and, in each week you had a block of content there, the texts to read, a video, a PowerPoint presentation narrated by the teacher, and at the end of that you had some content there, there was a multiple-choice test in which you had to get right, I think more than fifty per cent, otherwise, you had to repeat, you could repeat, I think we had three chances to repeat the test. That's it!*

In contrast to the more passive MOOCs, Beatriz characterises the more active MOOCS as being centred on activities that require outputs by the trainees, as well as some form of interaction between trainees.

> *[So] yes, [the participants] have to produce things in all the modules, even in the robotics module, which was the most complex module to define the format to happen at a distance. There are some work resources that were laid out, and some activities that they have to do, even in a virtual environment. (...) So, the idea is that MOOC participants effectively develop projects that they can then replicate in the classroom with their students. So, they will think of a project and choose a particular area or a particular curriculum content and try to take this content into their project.*

Table 2: Summary table of some activities to be carried out during the course (Module 4)

Module/ Topic	Learning Unit	Activity	Time (min.)	Resources
M4/4.3	Coding game off	CodyRoby	45	Jogo CodyRoby + Forum
M4/4.3	Robot online	Bee-bot online	45	Bee-bot online + Forum
M4/4.3	Plan an educational robotics activity	Plan activity	60	Educational robot (free choice) + Forum
M4/4.4	My e-portfolio - Part 4	Include robotics content and reflections in the e-portfolio	60	Padlet + Multiple Choice
Forum M4	Conversations on curricular integration of Robotics	Educational Robotics Forum	n.d.	Forum

Source: Translated from the MOOC Course Plan

In Beatriz's opinion, between the initially planned MOOC, of a more connectivist nature, and the currently proposed MOOC, an "intermediate solution" was found, which definitely does not characterise it as a MOOC based exclusively on contents:

> *I think it is an intermediate version. So, we managed to guarantee a minimum of co-llaboration, right? A minimum of interaction between the participants (...) we tried to guarantee some aspects of a more connectivist approach. In a more socio-constructivist perspective in the sense of making them able to work in groups, ensuring an evaluation activity among peers.*

Figure 3 shows the screen of the peer assessment activity, in which trainees are invited to visit and assess the e-portfolios produced by one of their peers and evaluate it, based on a previously defined rubric.

Figure 3: Screen Peer assessment activity

Source: Course environment on the NAU Platform

Table 3 shows the descriptions of one of the four criteria that make up the rubric of peer review of the electronic portfolio.

Table 3: «Creativity" criterion of the peer assessment rubric

Criterion: Creativity	
1. Beginner	The design of the e-portfolio does not include original and innovative ideas
2. Apprentice	The design of the e-portfolio includes a few original and innovative ideas
3. Proficient	The design of the e-portfolio includes some original and innovative ideas
4. Specialist	The design of the e-portfolio is composed of many original and innovative ideas

Source: Translated from Course environment on the NAU Platform

For Beatriz, applying the principles of what she considers to be an active MOOC, the trainee, in the proposed MOOC, is not just a mere receiver of contents and questions to which he/she has to answer, he/she has to produce projects and activities. The MOOC would thus be centred on contents and activities that require production by the trainees, activities that can be shared with their colleagues:

> *Now, the idea is that they can organize what they manage to implement into their e-portfolio and then share it. And we also have the forums, which are not for compulsory participation, the idea is that we create questions there, that encourage them to implement and bring their questions or report situations and activities they have implemented.*

Apart from the projects and discussions in the Forum, Beatriz also underlines the importance of e-portfolios:

> *[Trainees] should build something beyond the MOOC environment. That is the case with the e-portfolios that we are proposing that they build throughout the training. It would be a product that is outside the platform and becomes their own product that they can then disseminate, and it can as well serve as an environment of exchange, something that remains beyond that moment of training. That's basically it.*

At the basis of the e-portfolios is present the idea of the production of something that goes beyond the very realization and duration of the MOOC:

> *BEATRIZ: (...) the idea is to ensure a legacy, which extrapolates the training because in time they lose access to the space of the MOOC platform. In the case of the e-portfolio (...), it is a personal learning space, which they can use afterwards (...). We think that the e-portfolio can stitch together all the training and, in the end, allows them to arrive at a product that is greater than the training itself. Thus, for each activity developed, they are asked to publish their e-portfolios. For example, I did a computational thinking project, I'm going to post it, so everyone can see it.*

Figure 4 shows the NAU screen with the wording of part 3 of the e-portfolio construction.

Figure 4: Activity "My e-portfolio - part 3

Source: Course environment on the NAU Platform

By way of balance BEATRIZ defends that despite all the discussions a project of a MOOC was actually achieved which is a compromise between the original idea of developing a MOOC of a more connectivist nature and a MOOC of a purely self-instructional nature eventually imposed by the limitations of resources and also by the prevailing ideas of some of the participants in the project:

> *So, I think the fact that we managed not to go for a self-instructional version, totally focused on the content, is an added value. After all the discussions we managed to guarantee some important aspects, right? Both in terms of interaction and pedagogical design.*

If we use the typology referred to above regarding the Interaction Equivalence Theorem (Miyazoe & Anderson (2013) we can state that the proposed MOOC mobilizes two of the types of interaction proposed by that model: interaction between learners and content and interaction between learners and learners. Or as Beatriz says: "it is focused on both levels of interaction (...) and thus in equal importance".

5. DISCUSSION AND CONCLUSIONS

We have signalled before that Learning Design should be viewed both as a process and as a product. Relating to the process of development of a MOOC we have explored in this paper topics related to 1) the establishment of a common vision regarding the aims of the MOOC; 2) the socio-technical issues posed at the level of instructional design when facing new technological challenges; 3) the disruption caused in many content specialists by the process of development of a MOOC due to the fact that those specialists are mainly used to face-to-face education and 4) the discussion of the pedagogical philosophy in which the MOOC should be based.

Naturally one of the main limitations of this study is its lack of triangulation with other sources, stakeholders, and participants due to the fact that, for example, we didn't interview directly the content specialists, something that we intend to do in another work. Given this, we can say that

these results essentially reflect the perceptions of a more restricted core of the MOOC developers.

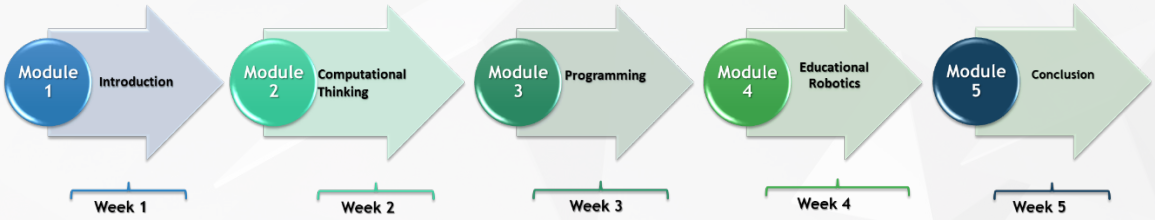
We can say that several problems of systemic nature go through this project, such as the lack of financial resources and time that we have not analysed here in detail or unexpected constraints such as the Covid19 pandemic. Overall, we have analysed some of the difficulties and contradictions that arise in terms of reaching a common vision regarding the aims of the MOOC and its relevance for teacher education. These contradictions end up impacting the development of the MOOC both at the level of its pedagogical design and at the level of the production of content for a totally virtual environment. These difficulties are perceived by the MOOC development team as being mainly due to the resistance of several of the content experts toward fully online training. As they are especially geared toward face-to-face training, even though they are specialists in educational technologies, offering fully online training requires a disruption in their beliefs and ways of working, which is not always easy to achieve. We have also seen that analysis from a framework of the socio-technical context and on-the-job learning is particularly useful to understand many of the difficulties in the process of learning design, a process that always has a double aspect: social and technical. The analysis of the discussion of the pedagogical model to be implemented in the MOOC proved to be of great interest and shows how from pre-existing theoretical models there will always have to be a local discussion that mobilises appropriate solutions to the reality of each context. This process is not without difficulties. When we asked the project coordinator how she would classify the degree of difficulty with which she was confronted, she classified it as "very difficult".

Overall, we are certainly in agreement with Freire (2020) when he states:

> *It is essential for online education leaders to realize that there is no one-size-fits-all or assembly-line type of all or assembly-line type of solution that can account for the multidisciplinary, multinational, and multi-tool collaboration requirements of like the HDF. Instead, leaders seeking to implement MOOC programs will be better off designing for complexity and a plurality of socio-material work streams rather than trying to impose rigid processes that garner little compliance among key stakeholders. Ultimately, while ensuring certain fundamentals like interactivity, scalability, and security, organizations ought to favour responsive technology systems that reflect the non-linear and heterogeneous ways of working of an increasingly diverse and geographically dispersed workforce.* (p. 395)

In what concerns the dimension of learning design as a product we can state that the MOOC is still in the development and production phase. The MOOC is entitled "Computational Thinking, Programming and Robotics in Basic Education" and is structured in five modules, lasting one week per module, with a total estimated dedication workload of 25 hours. The MOOC aims to promote the development of essential skills so that nursery and primary school teachers can integrate computational thinking, robotics, and programming strategies into their teaching activities. To meet this objective, three target competencies were defined, which revolve around identifying opportunities and planning activities that integrate computational thinking, robotics, and programming into the curriculum.

Figure 5: Basic Structure of the MOOC



Source: Translated from the MOOC Course Plan

In what regards the product as it stands at the present moment, we can say that the design that is defined for the KML II MOOC is not exclusively based, in pedagogical terms, neither on the principles of a cMOOC nor on those of an xMOOC. However, it includes elements typical of each of these two types. The proposed MOOC, despite having resources designed and prepared in advance, such as videos, texts, and activities, typical of xMOOCs, seeks to introduce some connectivist practices of participation, adhering to the four principles of Downes (2010): autonomy, diversity, openness, and interactivity. These last principles are guaranteed in the design by the types of activities proposed, which seek to promote the creation of networks that extrapolate in time and space the proposed course, promoting interaction and sharing among participants.

Considering the theoretical framework studied, the data collected from the target audience, and the challenges faced by the development team, the instructional design of the KML II MOOC went through a series of adaptations, but always seeking to guarantee some principles that we will now list:

Experience-based design: all the resources from videos to texts bring real case reports and the foreseen activities guarantee authentic experiences carried out in an educational context. Autonomous and flexible learning path: despite being organised for weeks; the MOOC allows the development of activities at an individual pace. In addition, it allows each participant to define the pathway they want to follow based on their professional profile (teacher or nursery school teacher), previous experiences, and individual objectives. Collaborative learning: even though the design is reasonably flexible and allows for a fairly autonomous trajectory, strategies to enable interaction between participants are valued, such as the forums created for each theme and strategies for sharing productions and evaluations between peers. Stimulation of the creation of learning communities: it is especially encouraged in the forums and in the activity of creating an e-portfolio, which runs throughout the MOOC, being characterized as a place for sharing productions and as an opportunity for interaction that goes beyond the time and space of the course. Peer assessment and feedback: The assessment process is based on assessment activities with explanatory automatic answers (tests and quizzes), self-assessment (questionnaires and e-portfolio), and peer assessment (e-portfolio).

In what concerns the dimension of learning design as a product we can state that the MOOC is in the final stage of the production phase and will only be implemented in this academic year (2022/23), so it can be said that this course proposal has not yet passed the reality test. In terms of research, there is still a lot of work to be done both during the running of the course as well as in concerns the evaluation of its final results.

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