A Moodle-centric Model and Authoring Tool for cMOOC-Type Courses

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Abstract: The use of learning management systems gives rise to many difficulties for teachers and instructional designers in terms of designing their courses. These difficulties are mainly related to the operationalisation of pedagogical scenarios and the use of the corresponding tools, especially in a connectivist context. The work presented in this paper focuses on learning design models for massive open online course (MOOC) environments, and more specifically on assisting teachers in the design and implementation of pedagogical scenarios for connectivist MOOCs (cMOOCs). The major contribution of this work is a visual authoring tool, based on business workflows for the design and deployment of cMOOC-oriented scenarios on the Moodle platform. The tool was also evaluated, primarily from the point of view of utility and usability. The findings confirm that our tool can provide all the elements needed to formalise and operationalise such courses on the Moodle platform.

1 INTRODUCTION

Learning theories have long been a subject of wide discussion in the educational field. They provide concepts that contribute to the extension of teaching methods and learning practices. There are several approaches that can be mentioned here, such as socio-constructivism, behaviourism and constructivism. These approaches reflect several developments in the educational field, and are in line with common practices in actual learning, including computer-based learning environments. Many researchers have explored the limits of these approaches, and particularly of the behaviourist conception of teaching and learning. Piaget was one of the first to demonstrate the limits of this approach by highlighting the importance of taking into account the progressive adaptation of each learner's learning process in all pedagogical approaches (Weegar & Pacis, 2012). Several authors have criticised the theories of behaviourism, cognitivism and constructivism, on the basis that although these are the most common teaching theories, they cannot meet the challenges of the contemporary world (Černý, 2020; Gonzalez, 2004).

The evolution of the internet and the advent of social networking have created interconnections between users that were previously impossible. Technology is changing the ways in which we think and behave, and the ways in which we solve problems and handle information. These changes are obvious and fundamental, and it is impossible to ignore them (Černý, 2020). To take advantage of these changes, Siemens introduced a new learning approach in 2005 called connectivism, which he described as "*a learning theory for the digital age*" (Siemens, 2004). In his opinion, this new learning approach addressed the limitations of previous learning theories within a world driven by Web 2.0 technologies. Siemens (2004) firmly anchored his theory in other traditional learning theories, while describing these as inadequate in the face of the new and revolutionary social networking technologies affecting research, teaching, and learning. With the advent of connectivism, the specific needs of the digital world, and particularly of online platforms and their influence on learning, are increasingly taken into account. This progress has led to the emergence of MOOCs, which have recently demonstrated tangible success for various educational stakeholders. According to the co-founders of the first connectivist course, the structure of such courses is based on four practices (Downes, 2008; Kop, 2011): aggregation, remixing, repurposing, and feed forwarding. A fifth

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category that involves evaluating activities was assed to this categorisation (Bakki *et al.* 2019a).

Educational institutions increasingly rely on MOOCs as a new form of pedagogical support and to modernise their curricula. In addition to the supporting role of MOOCs, a new pedagogy is emerging that is enhancing or redynamising face-to-face (F2F), distance and hybrid teaching. However, the design of a connectivist course, known as a cMOOC, though a learning management system (LMS) presents several challenges that are related to the assimilation of the design features of such courses and to the operationalisation of scenarios by teachers. This is particularly important in regard to the low progress of these systems, as demonstrated in an analysis conducted by Toven-Lindsey *et al.* (2015) of a range of 76 MOOCs, which revealed that only 10% of these courses could be categorised as cMOOCs. In addition, pedagogical practices related to connectivism are not explicitly embedded in the pedagogical model of an LMS. Some platforms, such as Moodle [1] or OpenEdx [2], do not reduce this complexity; nevertheless, the provision of adequate support and facilities is difficult, despite the large and active communities involved. In addition, since each platform is based on a specific instructional design paradigm and a specific pedagogy, practitioners are often unfamiliar with this implicit type of instructional design method (Abedmouleh, 2013; El Mawas *et al.*, 2016; Martinez-Ortiz *et al.*, 2009).

This research work was carried out as part of the Pastel research project. A key objective of this project is the design of a process for incorporating new technologies into pedagogy and teaching. This process can be divided into the three main phases of capitalisation, scenario design and operationalisation, which are required to set up an editorial process. The work presented in this paper focuses on the first two phases of the editorial process and provides solutions for designing and operationalising pedagogical scenarios. In order to promote and facilitate the implementation of cMOOCs by teachers and instructors using the Moodle platform, we propose a visual editor that includes concepts closely related to the Moodle platform. We provide graphical notations that are more user-friendly and which better address the needs of the user than the XML syntax that is usually provided. This paper focuses on learning design models and addresses ways of constructing an LMS-centric language that combines a pedagogical model for a particular platform with a specific pedagogical approach. The paper is structured as follows: in Section 2, we discuss some related work associated with our research problem, and analyse the relationships between LMSs, instructional design and MOOCs. Section 3 describes our approach, defining a Moodle-oriented pedagogical model for the context of a cMOOC. This section also describes our principal contributions, namely the authoring tool and the operationalisation service. Section 4 presents an evaluation of the proposed tool. Finally, Section 5 draws some conclusions and outlines some directions for future work.

2 RELATED WORKS AND RESEARCH AIMS

2.1 Instructional Design and LMSs

The emergence of technology is constantly expanding the possibilities for online learning, and continues to contribute greatly to the evolution of e-learning. LMSs or learning support systems (LSSs) are defined as online learning technologies for the creation, management and delivery of online content.

In today's ubiquitous digital environment, LMSs play an important role in improving and facilitating distance teaching and learning. An LMS can not only enable the delivery of digital instruction and resources, which can improve and increase the quality of learning in a collaborative environment, but can also allow teachers to focus on designing their teaching activities. We note that the design of pedagogical situations on learning devices such as educational platforms or LMS systems is not a straightforward task. A large number of teacher-designers face certain constraints when using these platforms to design pedagogical scenarios (Steel, 2009). They are not accustomed to the implicit pedagogical design language used (Martinez-Ortiz *et al.*, 2009), and are not able to implement the scripts required by the platforms (Mekpiroona *et al.*, 2008). The main challenges relate to the specification of functionalities, based on their knowledge about the LMS and their skills in terms of pedagogical conception. This is especially important since pedagogical designs on LMS platforms are not sufficiently flexible, and impose a specific paradigm. Despite the existence of standards (Martinez-Ortiz *et al.*, 2009; Mekpiroona *et al.*, 2008), approaches (De Vries *et al.*, 2006), languages (Baggetun *et al.*, 2004), architectures (Alario-Hoyos *et al.*, 2013), and tools

[1] https://moodle.com/

[2] https://open.edx.org/

(Zedan & Al-Ajlan, 2007) that aim to promote and improve the use of platforms through the specification of graphical instructional languages and platform-centric authoring tools, these are generally incompatible with the platforms. In addition, they do not facilitate the operationalisation of the designs that are produced. This means that several modifications to the initial scenario are required. Resulting in a loss of information and semantic during the operationalisation of the scenarios described outside of the platforms (Abedmouleh, 2013).

As part of their research work, El Mawas *et al.* (2016) and Abedmouleh *et al.* (2013) have described a process for identifying and formalising the pedagogical practices embedded in distance learning platforms, based on a metamodelling approach. The advantage of this proposal is that the identified language can be used as a basis for the development of new pedagogical conceptions and authoring tools. Solutions that rely on the definition of the platform's pedagogical model have a second purpose. They also provide a communication bridge between authoring tools and the platforms concerned. In addition, adopting a platform-centric language can preserve the semantics of the pedagogical scenarios, meaning that these scenarios can be implemented with limited information loss. As part of our work, and in order to develop a connectivist-oriented scenario model centred on the Moodle platform (as described in Section 3.1), we relied on this process when identifying and formalising the embedded pedagogical aspects in the LMS. Our main objective was to identify cMOOC-oriented pedagogical concepts embedded in Moodle in order to provide solutions for assisting and supporting teachers interested in adopting Moodle as a platform for delivering cMOOC-based courses. Further work is detailed in Section 3 of this paper.

2.2 LMSs and MOOCs

Since their emergence, MOOCs have been adopted by a significant number of educational institutions. Shah (2019) states that in 2018, more than 900 universities worldwide announced or launched more than 11,400 MOOCs, and 101 million students signed up to study a wide range of topics such as technology, economics, social sciences and literature (Bonk & Zhu, 2018). The purpose of these courses is to contribute to the generalisation of learning, both for students and for individuals who want to undertake lifelong learning. It is also to extend education to persons who, for social or geographical reasons, presently lack access to training (Bakki *et al.* 2015). These environments are distinguished by several characteristics, such as massive numbers of learners, openness to all, accessibility on a large scale, the nature of the qualifications and content, the evaluation modalities, etc. They are based on existing LMSs such as OpenEdx[3] and Moodle[4].

Studying in an open and networked environment such as a MOOC is challenging, since control of educational activities is handed over from educational institutions to individuals, who are generally isolated learners (Fournier *et al.*, 2014). Tasks that were previously carried out by a teacher, such as setting pedagogical objectives and evaluating a student's progress, can now be assigned to learners. These tasks may be overwhelming for learners who are unaccustomed to learning environments that require them to be self-directed and self-regulated (Kop, 2011). Several research studies have addressed specific issues related to these characteristics from different perspectives. Furthermore, a large number of research studies on MOOCs have been essentially learner-centred, and have addressed various issues related to drop-out rates, engagement or motivation using various approaches such as trace analysis, for different purposes, such as adaptation, personalisation, etc. (Abrache *et al.*, 2016; Alario-Hoyos *et al.*, 2014; Bendou *et al.*, 2017; Hmedna *et al.*, 2019; Lee *et al.*, 2016; Pilli & Admiraal, 2016; Ramírez-Donoso *et al.*, 2017; Wang *et al.*, 2018; Zheng *et al.*, 2016). However, few works have addressed issues related to teachers. In this regard, several research questions can be highlighted, for example: what role does the teacher play in these massive and open environments? What are the teacher's needs when implementing these environments? What tools and methods have been proposed to support the teacher's activities (design, deployment, monitoring, analysis, etc.)? In our work, we are particularly interested in the second of these research areas. We focus mainly on the design of pedagogical scenarios, and especially on the process of scenario design for cMOOCs, and their deployment on specific LMSs.

An analysis of the environments currently used to implement MOOCs led to the identification of Moodle and OpenEdx as the two LMSs that are most widely used to support these types of learning environments. Based on this analysis, we examined and compared the functionalities of these two LMSs. The objective was to identify the connectivist-

[3] www.edx.org, www.fun-mooc.fr

[4] http://mooc-culturels.fondationorange.com/

oriented functionalities embedded in these two LMSs. As shown in Table 1, Moodle provides a more diverse range of solutions for teachers who intend to adopt connectivism as a pedagogical approach. In addition, Moodle has been used for about 13 years in the educational system. Moodle is also a free LMS system that is predominantly used in universities. In fact, according to statistics from Moodle, the number of Moodle users is currently approximately 247,414,610. Conceived as an open source platform, it has a community of developers and technological contributors who have created plugins for a variety of needs (Dougiamas & Taylor, 2003). A plugin is a software component that adds or expands a specific feature to complete a software application. It may also enable the customisation of an interface or other features depending on the user's needs, such as accessibility. For these reasons, we chose the Moodle platform as our area of study and analysis.

3 A MOODLE-CENTRIC AUTHORING TOOL IN A CONNECTIVIST CONTEXT

3.1 Towards a Moodle-oriented Pedagogical Model for the cMOOC Context

In this paper, we are specifically interested in the identification and formalisation of the implicit cMOOC-centric instructional design language used in LMSs. This language will form the basis for the development of binding solutions that will simplify instructional design on the Moodle platform. These solutions must ensure that pedagogical scenarios that are formalised in conformance with a proposed language can be operationalised in the LMS, with a reduced semantic loss. In order to identify the pedagogical core of the Moodle platform, and more specifically to identify connectivist-oriented pedagogical concepts, we adopt a platform-centric approach.

We do not intend to enhance the semantics of the pedagogical model embedded into the Moodle platform. According to Abedmouleh (2013), an LMS is not pedagogically neutral but embeds an implicit language that is used to describe the process of designing learning activities. Thus, our proposition is based aims to identify the connectivist language embedded in the Moodle platform and then to explicitly formalise this language in a computer-readable format. This format can be used as a binding format for various external tools with different design aspects. Our approach involves carrying out a functional analysis of the Moodle platform, in which we rely on the work conducted by El Mawas *et al.* (2016). We have previously conducted a study of the current state of the art in terms of the pedagogical scenario design aspects of cMOOCs, and have put together a compendium of teachers' needs related to the design and deployment of such courses, resulting in a set of criteria and elements that regulate scenario design in a cMOOC course (Bakki *et al.* 2019a). This exploratory work also allowed for the abstraction of a pedagogical model from existing cMOOCs, and some of these elements are presented in Table 1.

Table 1: Connectivism vs. OpenEDX - Moodle elements mapping.

	Associated Bloom Taxonomy Concepts	Activities	Moodle	OpenEdx
Aggregation	Read, search, categorize, quote, read, etc.	Consultation Cognition	Page, URL, resource	Video, File, HTML
Remixing	Select, identify, argue, criticize, justify, recommend, adapt, discuss, illustrate, summarize, interpret, etc.	Metacognition Sharing Communication	Chat, Forum, LTI, Wiki, Glossary, Journal	Forum, HTML page
Feed Forwarding	Share	Sharing	Page	HTML
Repurposing	Compose, construct, create, elaborate, plan, reorganize, represent, schematize, write, etc.	Production Collaboration	Workshop, LTI	xBlock LTI
Evaluation	Examine, test, evaluate	Evaluation	Quiz, Workshop	Quiz

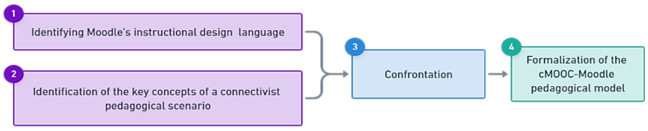

Figure 1: Construction process of our Moodle-centric scenario model.

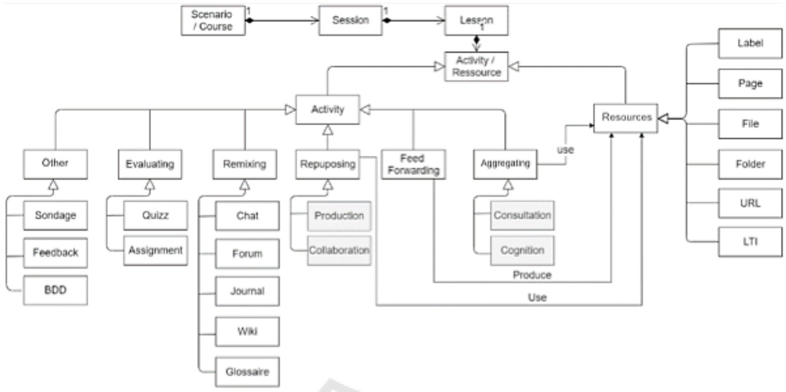

Figure 2: Moodle-centric pedagogical scenario model for cMOOC context.

The next step is therefore to combine this abstract pedagogical model with the requirements identified for the cMOOC scenario design language, and the main characteristics of a connectivist course (Figure 1). We also conduct a functional analysis of the Moodle platform, which allows us to identify the pedagogical model of the platform based on the results reported by El Mawas *et al.* (2016) (Figure 1).

These two models, namely the *connectivist pedagogical scenario model* and the *Moodle-centred pedagogical model*, lead to specifications for these models from two different perspectives. A comparison (confrontation) between these two models is then carried out (Figure 1-3), which allows us to formalise the final conceptual language. The objective is to combine the platform's pedagogical architecture with the elements of the connectivist pedagogical scenario, in order to build a representative model. This phase essentially involves comparing, factorising and structuring the elements of both models. Some parts of the models may be identical, complementary or at different levels of abstraction. The methodology consists of verifying the elements of the respective models based on several points, including the definition of similar elements, the non-existence of certain elements, or the generality or specificity of the relationships between particular elements. The general concept of this comparison is as follows: (i) we first verify the non-existence of one or several elements, if applicable; (ii) we identify a specification or generalisation relationship between the model's elements; (iii) otherwise, we verify the difference of the definition of the element in each model. More specifically, we verify whether elements are at different levels of abstraction. When all elements have been verified, we obtain the Moodle-centric pedagogical scenario model illustrated in Figure 2.

3.2 A Moodle-oriented Authoring Tool

In this section, we will present our visual authoring tool for pedagogical design, which allows to specify learning situations and then implement the pedagogical scenarios to the Moodle Platform using the deployment service. The use of graphical notation to provide a visual syntax for modelling languages has been developed and put into practice in many different domains, and graphical notations have also been developed to reduce the cognitive load when working with complex semantic models. They provide a comprehensive notation that can be clearly understood by a wide range of users. In this vein, we use an extended BPMN graphical notation (OMG, 2011) for the design of our pedagogical scenarios.

BPMN notation has many advantages as a pedagogical modelling language, and has been used to design various pedagogical situations in several contexts (including F2F, hybrid and collaborative environments) (Da Costa, 2014; Stylianakis & Arapi, 2013). The use of the BPMN was motivated through an exploratory study of existing modelling languages.

We compared the BPMN language to other pedagogical modeling languages according to two prevalent classifications, presented by Botturi *et al.* (2006) and Nodenot (2007). Regarding the page limit of this paper, more details on the conducted study can be found here (Bakki *et al.* 2019a). BPMN meets our requirements from the technical and descriptive aspects contained in Botturi *et al.*'s (2006) classification and according to the pedagogical scenario aspects (such as role representation, sequencing, collaboration, etc.) presented in Nodenot's (2007) classification.

However, in order to meet the requirements to provide the teacher with support in terms of designing cMOOC-oriented pedagogical scenarios, we cannot use BPMN as it stands. The specifications for BPMN not only involve the use of graphical notations for process descriptions, but also definitions of abstract metamodels for these domains. We therefore propose an extension to the concepts underlying BPMN, which takes into account the specificities of a cMOOC scenario by defining an abstract model and a particular graphical notation for this model. We then embed this extended notation and model into our tool. The notations include elements describing the roles of participants, the learning sessions, the different categories of activities, and the resources and sequencing of activities (Figure 3A).

The objective is not to build a new platform, but to start with an existing tool and extend it. We therefore selected the BPMN.io tool[5], an open source web application that uses BPMN 2.0 notation (OMG, 2011). Developing an extension to BPMN notation is not the purpose of the current paper (Bakki *et al.* 2019b). Instead, we mainly focus on the presentation of the tool's functionalities, the extension of the visual notation and the development of a Moodle operationalisation service. In the following section, we will take an example in order to illustrate our proposal. This example involves a week's activities as part of a MOOC, on the topic of *digital identity*, as shown in Table 2.

Table 2: Example of a textual pedagogical scenario.

Lesson	Activities	Type
Discovering the subject	Consulting a collection of resources to discover the subject of the week	Aggregation
	Conducting a web search on digital identity.	Aggregation
	Examining the key elements that build a user's digital identity	Remixing
Exploring and discovering the interests and ideas of learners	Writing a blog post on the topic	Remixing
	Discovering the publications of others	Aggregation
	Exchanges on the forum	Remixing
	Explaining and discussing acquired ideas with peers; interacting proactively in the chat room	Remixing

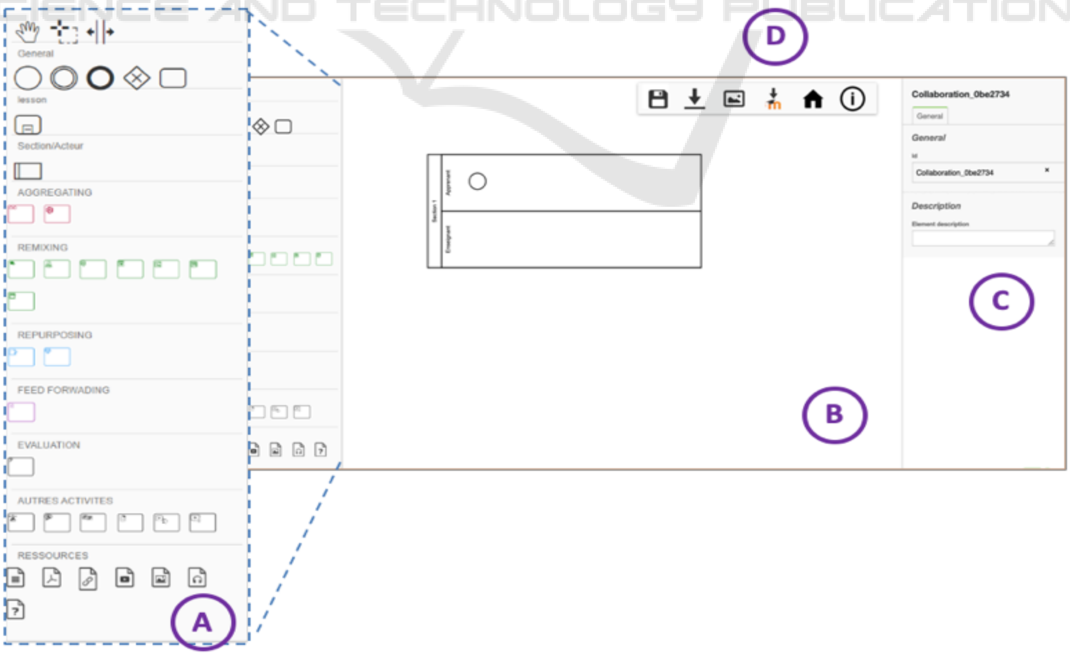

Figure 3: The main interface of Visual Authoring Tool.

[5] http://bpmn.io/

3.2.1 From a Pedagogical Need to a BPMN Pedagogical Scenario

We propose an authoring tool for teacher-designers using the Moodle learning platform. This tool provides a graphical interface for the design of pedagogical scenarios by combining the elements of a connectivist pedagogical scenario with a pedagogical design language that is specific to the Moodle platform. It is a web application that reifies the pedagogical model presented in Section 3.1.

Once the teachers are connected, they can either create a new scenario or modify an existing one. In the following, we consider that teachers have chosen to create a new scenario. After specifying the name of the scenario and choosing the blank model, the teacher is directed to the conception page. When starting the scenario conception process, the teachers first create a learning session. They access this via the toolbox on the left of Figure 3A, in the *learning session* block.

In order to support teachers, we ensured that the modelling space was not empty when creating a new scenario (Figure 3B), and an initial learning session is therefore created by default. In a MOOC, one session typically represents one week. The teachers are then provided with an interface containing a pool, which can be renamed or deleted. They can use the *Properties* section (Figure 3C) to specify the duration of this session (the start and end dates).

After creating their first session and specifying the roles, the teachers can start creating different lessons. We assume that a lesson encompasses a number of activities. The teachers can continue modelling by dragging the activities they want to include from the toolbox into the model. In order to facilitate the identification of activities, according to the four principles of a connectivist course, we classify them into four blocks with different colour codes.

Each activity has its own properties; for example, for a consultation activity, the teachers specify whether to use a resource, a page or a URL that describes the activities to be carried out or presents a description of the progress of this activity. If teachers want to set a resource, they specify its type and the link to access it. The example presented in Table 2 illustrates this process. Once the teacher has designed all the activities, s/he will produce a workflow, as shown in Figure 4 (1).

Once modelling is complete, the teachers can save the scenario in different formats or deploy it on an online platform using the *Export to*... button (Figure 3D). This action transforms the BPMN file into one that can be imported by the Moodle platform.

3.2.2 From a Pedagogical Scenario to a Moodle Learning Environment

In order to support the teacher, a service allowing for the deployment of pedagogical scenarios was developed. Operationalisation represents an intermediate phase between learning and scenario design, and the aim of this step is to ensure that the scenario described by the teacher can be used and manipulated in a LMS while preserving the pedagogical semantics (Abedmouleh *et al.*, 2011). Our contribution uses hybrid approaches based on processes and tools inspired by and/or applied in model-driven engineering (Bonk & Zhu, 2018).

We implement an operationalisation service that allows teachers to automatically deploy their pedagogical scenarios on the Moodle platform, using the transformation described in Section 3.2. To do so, we provide a solution that allows the pedagogical workflow to be transformed into a deployable scenario. As illustrated in Figure 5, we propose a two-phase approach.

(1) Transformation/Pretreatment. The aim at this stage is to propose a confrontation (comparison) between the pedagogical scenario and the elements of Moodle, in order to resolve any ambiguities and to match each concept in the scenario with a concept in the chosen platform.

The general idea of the transformation algorithm follows that described in Section 3.2. After the BPMN pedagogical workflow has been generated, the scenario is transformed into the format required by Moodle, which in this case is the JSON format (Figure 5). The teacher can also export the course in MBZ format (Figure 5), via a process in which the BPMN scenario is transformed into a set of XML files. In practice, this transformation involves making a backup of the Moodle course using the platform's import functionality; our transformation engine then modifies the backup archive with the information contained in the BPMN file for the new scenario.

Finally, the teacher can import the modified course manually into the Moodle platform. In our example, after designing the lesson, the teacher can deploy this scenario on the Moodle platform. Pressing the *Deploy* button applies a pre-treatment phase that runs in the backend and generates a JSON file containing all the activities, by transforming the BPMN file using the mechanism described below. The JSON file for the example activities is shown in Figure 4 (2).

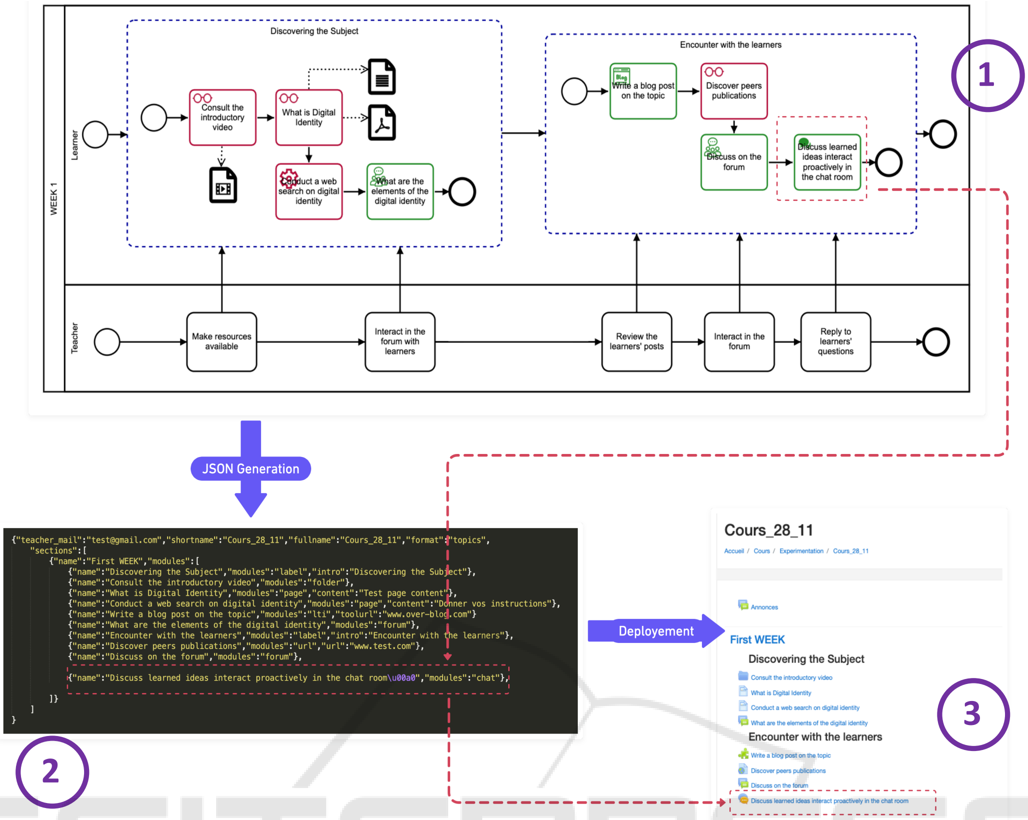

Figure 4: Illustrative example.

(2) Deployment. The operationalisation module acts as a communication gateway between our tool and the Moodle platform. For this purpose, we developed a web service as a Moodle plugin. The JSON file resulting from the preceding phase is sent via an HTTP request; this is received and interpreted by the developed plugin, which is automatically connected to the platform, and is then automatically executed using the *Create course* function.

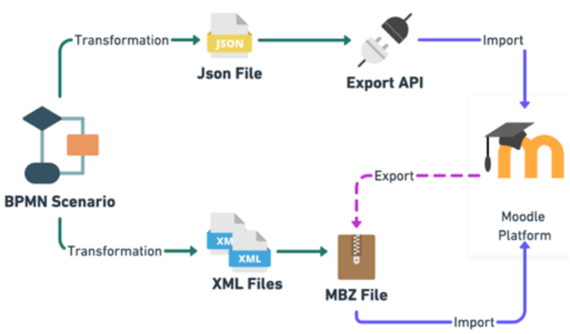

Figure 5: Moodle operationalisation process.

The Rest API that we have developed connects to the Moodle platform and deploys the different activities after generating the JSON file. Note that the transformation phase (i.e. the generation of the JSON file) and the Rest API are executed in the backend. Figure 4 (3) illustrates the Moodle course after deployment in our example.

4 EXPERIMENTS AND EVALUATION

4.1 Objective and Description

In this research, the contributions were evaluated and tested as they were specified through simulations and user tests. Although experiments in a real-world situation in which the tool was integrated into a cMOOC project would have been valuable, this was not possible, as it is risky for MOOC designers to rely on a research prototype.

However, a final evaluation was conducted in an experiment with 12 participants, to evaluate the usability of our authoring tool. We aimed to verify the ability of the proposed extension to create and model cMOOC scenarios, and to evaluate the Moodle deployment service. This experiment was carried out during a workshop, with users who had prior knowledge and experience with pedagogical scenario design and who had previously designed pedagogical situations and had used different instructional design tools. In our research context, it is very difficult to engage candidates. Due to space limitations, the experimental protocol and the results obtained will be summarised here. For our experiment, we follow a similar experimental protocol as presented in (Bakki *et al.* 2019b) with a separate group of participants.

4.2 Experimental Protocol and Data Collection

4.2.1 Experimental Protocol

Our evaluation protocol consisted of three steps, as follows. **(1) Preparation:** We provided participants with a user's guide that explained the philosophy and described the functionalities of the tool, and an experimental guide that described the different steps to be performed during this evaluation and the scenario to be deployed. **(2) Conception and deployment:** The aim in this step was for the participants to design a pedagogical scenario for a cMOOC according to the instructions provided during the preparation phase, and then to deploy this scenario on the Moodle platform provided. **(3) Results:** In this step, we asked participants to complete a questionnaire at the end of the evaluation, in order to validate the utility and usability of our tool and to obtain more information on their experiences.

4.2.2 Data Collection

The methodology used to collect the data in this experiment involved opinion data collected from the participants via a questionnaire. At the end of the experiment, participants were asked to complete an online questionnaire containing 25 closed-ended questions, which was evaluated using a six-point Likert scale. The first part of the questionnaire focused mainly on the expressivity of the notation and the deployment service. The second part measured the usability of the tool, and for this part we used the *System Usability Scale* (SUS) questionnaire (Bangor *et al.*, 2009).

4.3 Experimental Results

The first part of the questionnaire was divided into two sections. The first section aimed to determine whether the tool allowed the participant to produce a simple design for a connectivist course. This section also assessed whether participants were satisfied with the tool and whether the notation used in the tool was easy to understand. The final aim was to evaluate the potential of the tool in terms of designing a cMOOC course. In the first section of the questionnaire, 10 of the participants agreed that the layout of the toolbox allowed them to identify the elements, and indicated that the tool offered all the concepts required when designing a cMOOC course. Only two of them did not agree with this statement. All participants indicated that they had succeeded in formalising all the concepts of their scenarios. The second section of the questionnaire assessed the usability and utility of the deployment service. All of the participants completed this phase.

In total, 11 of the 12 participants reported that the operationalisation service was very useful, and 10 found the automated operationalisation service easy to use. A review of the feedback from participants revealed that their scenarios had been successfully deployed: between 75% and 100% of the designed concepts have been successfully deployed on the platform. These results are generally consistent with those of the scenario analysis. We noticed that some users did not fully complete the metadata, which explains the rates obtained. In the second part, the SUS questionnaire was used to measure the usability of our authoring tool. SUS is a popular and effective tool for assessing the usability of various systems (Bangor *et al.*, 2009), and uses closed-ended questions with a five-point Likert scale. Although only 12 participants were involved in this experiment, this was sufficient to detect any major problems with usability (Virzi, 1992). Before calculating the SUS score, we pre-processed the participants' responses to remove any errors.

In order to detect these errors, we used the grid presented by McLellan *et al.* (2012), which considers all responses provided with a score greater than three for all negative statements as incorrect. Of the 12 responses received, three were withdrawn. Overall, the average SUS score for all participants was 73.05, with a SD of 13.09. This corresponds to the 68th percentile, according to the standardisation presented by Sauro and Lewis (2011).

In accordance with the empirical rule for interpreting SUS scores (Bangor *et al.*, 2009), scores of less than 50 were considered unacceptable, scores of between 50 and 70 were marginally acceptable, and scores of above 70 were acceptable. Using this acceptability scale, an average SUS score of 73.03 indicates that our tool is *"acceptable"*, and a "*good*" result was obtained for the notation.

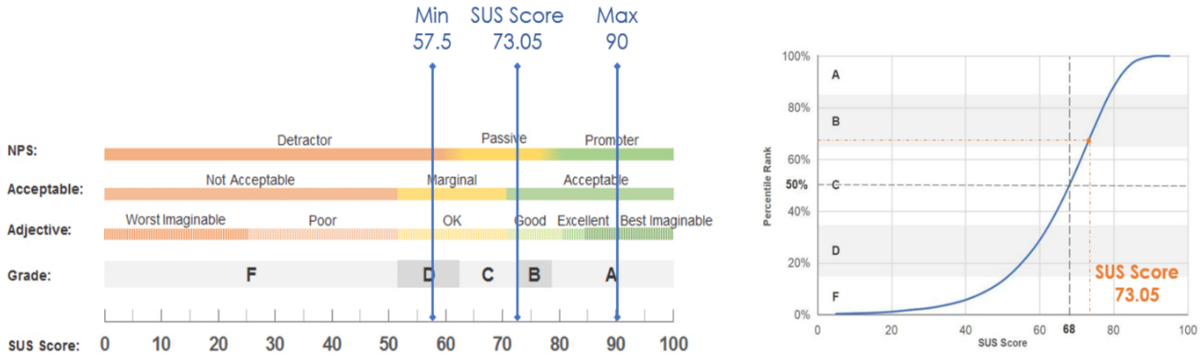

Figure 6: SUS Score.

5 CONCLUSION

In this paper, we have proposed a solution to support pedagogical scenario building for connectivist MOOCs. The work presented in this paper is a continuity of the work conducted in (Bakki *et al.*, 2019b). The latter is based on a pedagogical oriented approach. However, in this work, we are interested in a platform-oriented approach and more particularly in the Moodle platform. Thus, our main contribution is a visual authoring tool that allows for the design and deployment of cMOOC-oriented scenarios, using the BPMN model for graphical representation. We apply a two-step process, from the design to the operationalisation of pedagogical scenarios. The first step consists of modelling the scenario using our editor, which can be used by teachers without specific technical knowledge. The second step involves the automatic deployment of a scenario designed using a Moodle web service API.

Our contributions were evaluated and tested as they were developed, in order to verify them against the real needs of the ultimate users. The final evaluation was carried out with 12 participants, in order to evaluate the usability and utility of our tool, and was carried out via a questionnaire that was supplied to the participants when the experiment was complete. The findings confirmed that the tool allowed users to easily design and deploy connectivist pedagogical scenarios. In the context of a cMOOC, a course is initially designed by the teacher, and learners are then encouraged to adapt it based on their learning objectives. As a perspective of our work, we therefore consider that a methodology based on the co-design of a scenario that is currently in use would be a possible solution to this challenge, by giving access to the learners to tool with special and restricted roles and privileges. We will also explore the possibilities to evaluate our tool with a larger number of teachers and/or designers. We will also explore the possibility of evaluating our tool with a larger number of teachers and/or designers.

The contributions presented in this paper have a twofold purpose: firstly, our aim is to assist teachers in conceiving MOOCs, and secondly, we seek to bridge the gap between the design and deployment phases by providing technical solutions to teachers or educational institutions working with the Moodle platform. We would like to point out that the Moodle platform module is recognised as one of the most widely used platforms at the national and international levels, with more than 243,000,000 users and 31,896,069 courses. According to statistics from Moodle, their LMS is currently used by over 60% of higher education institutions all over the world [6].

A major strength of the Moodle platform is the two very active Moodle communities that have been formed over the years. The first concerns the pedagogical community (teachers and pedagogical engineers), whose exchanges are centred on the pedagogical model embedded into the Moodle platform. The second is a more tech-oriented community (Moodle API developers), who focus on providing technical solutions to Moodle users. Both communities could contribute significantly to the adoption of our solutions by educational institutions, and especially universities, which have started to deploy MOOCs over the last few years.

[6] https://stats.moodle.org/

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