Increasing the Reusability of MOOCs via Competence-Oriented Development

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***Abstract*— In this paper, we present a novel life cycle model for MOOC development that focusses on reusability. MOOCs can be used in various contexts: standalone, as an additional resource in a course at an established educational institution, or as the main driver for such a course in, e.g., a flipped classroom setting, among other uses. However, there is no established process how to design and run MOOCs in such a way that it enables their use and re-use in all of these contexts. Our life cycle model is based on a meticulous analysis of the competencies that each unit within the MOOC requires and provides. Based on this analysis, learning objects can be designed in a modular way so as to be easily reusable, clearly specifying their prerequisites, which can also be fulfilled by knowledge supplied from outside the MOOC itself. We illustrate this principle by examining our development of a MOOC about databases, where we follow the proposed life cycle model.**

Keywords*— MOOC development, MOOC reusability, competency graphs, MOOC life cycle model

I. Introduction

Massive Open Online Courses (MOOCs), a term coined in 2008 [1] after George Siemens and Stephen Downes taught their course “Connectivism and Connective Knowledge” to thousands of students over the internet, generally refer to online courses that are both free and open to the public, follow a specific curriculum, includes social interactions among learners, and where the outcomes depend on the engagement and self-organization of learners [2]. In 2014, the IEEE CS Report 2022 [3] predicted that professional degrees from accredited universities will be available through massive online format before 2022. Indeed, MOOC offerings have increased dramatically in the years since 2011 [4], and, in particular, the COVID-19 pandemic has caused a massive spike in MOOC enrolment and offerings [6].

MOOCs are offered in a variety of contexts [7]. Apart from the classical MOOC (also called “MOOC as a Service”), universities and other learning institutions are trying to integrate MOOCs into their established curricula and degrees [8]. This can happen in different ways, for example, by accepting MOOCs as equivalent replacements of hitherto face-to-face courses, or by using MOOC content in the classroom or as added material to aid student learning.

This, however, raises an important question: How should MOOCs be designed in order to easily usable in all these scenarios? In this paper, we aim to answer this question. To this end, we introduce a novel MOOC Life Cycle (MLC) model for MOOC development that focusses on reusability of MOOCs in various scenarios by ensuring that individual building blocks within the MOOC provide clearly delineated and well-documented competencies (i.e., learning outcomes) and only require a minimal set of competencies as prior knowledge. In this way, MOOC creators can use all or parts of a MOOC designed via the MLC in their own setting, be that in a different MOOC or as added material within a classical face-to-face course setting. This competency-oriented development of MOOCs is facilitated through the GECKO platform [9],which allows users to easily represent competencies and their interdependencies, aiding the MOOC development process.

A. Related Work

With the advent of MOOCs, research focussed on the classical “MOOCs as a Service” model with its “massive” and “online” components [10]. However, with the increasing use of MOOCs within traditional face-to-face learning settings, also this “blended learning” approach has been investigated [11] [12] [13] [14]. This research mostly focusses on how to integrate MOOCs into a classroom setting, and what pedagogical approaches to use when doing so. However, to the best of our knowledge, no comprehensive guidelines have as of yet been developed to aid MOOC developers in creating MOOCs that can be used and re-used in the various settings where MOOC content might be useful.

B. Contributions

We aim to tackle this problem and, to this end, offer the following contributions in the present paper:

- We introduce the MOOC Life Cycle (MLC) model for MOOC development. It consists of seven steps, namely, Requirements Analysis, Competence Bundling, Course Design, Content Development, Course Construction, Course Execution, as well as Analysis and Optimization.
- We give a detailed explanation for the novel aspects of the MLC, in particular, the Competence Bundling and Course Design steps.
- We describe how the focus on competencies (i.e., learning outcomes) and their interdependencies when creating MOOC content like videos, worksheets, or quizzes, allows for clearly separated units of learning that can be easily re-used in other course settings than the one the MOOC was originally designed for.
- We illustrate the use of our MLC MOOC development model by constructing an example MOOC focussing on the topic of databases. This MOOC is constructed with reusability in multiple different settings in mind. It consists of several learning objects whose requirements and learning outcomes are clearly documented and form a graph-like structure that can be used to re-structure and re-use (parts of) the MOOC in settings like a traditional MOOC, blended learning approaches in the classroom, as well as the basis for different MOOCs building on or treating the same subject matter.

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C. *Structure*

The remainder or the paper is structured as follows: In Section II, we give an overview of the state of the art of MOOC use in different settings In Section III, we then introduce our MOOC Life Cycle model for competence-oriented MOOC development. Section IV illustrates our approach based on a database MOOC we created using the new life cycle model. We then conclude in Section V.

II. Problem Description and State of the Art

MOOCs today are often developed with one of two target groups in mind as their primary audience: (1) online learners, who engage with the MOOC voluntarily, where there is no direct alignment with a traditional course of a particular curriculum, and (2) learners, who complete the MOOC online as a replacement for a traditional course in their curriculum.

A. *MOOCs and Self-Learning Scenarios*

In MOOCs developed for target group (1), also referred to as ‘MOOCs as a Service’ [7], special competency requirements of a curriculum often do not matter. For this target group, MOOC developers generally pick a selection of topics and content relevant to their MOOC and then structure them in a way that they deem appropriate for their target audience. Such MOOCs often try to maximize their reach and appeal to as many potential participants as possible and provide specialized learning scenarios, since their primary aim is to be a pure self-learning course or minimally supervised by a few MOOC instructors—often the MOOC designers themselves. These MOOCs usually run for a few weeks only. All data generated while learners work through the MOOC remain on the MOOC platform exclusively.

A ‘MOOC as a Service’ concludes with a certificate. However, the voluntary nature of the MOOC without supervision can result in high dropout rates among participants. Certificates of these MOOCs are mostly not being acknowledged at schools or universities as a replacement for attending a traditional course (a) because of content alignment issues, and (b) because of the lack in transparency of the activities and achievements of the learners on the MOOC platform, which is generally completely disconnected from the educational institution in question.

On the other hand, in a MOOC designed and developed for target group (2), also called a ‘MOOC as a Replacement’ [7], we can typically observe a high alignment of the MOOC content with that of an existing course in the relevant curriculum, but a lower level of infrastructure, services, and instructional support at the designing institution. Often, such MOOCS are developed by MOOC designers with the express objective to replace courses at their own institution or on behalf of clients with very specific content and assessment requests, so that the MOOC matches the relevant curriculum. All data generated while learners work through the MOOC remain on the MOOC platform exclusively. Only the MOOC developers themselves have access to the activities and results of the learners. Due to insufficient content alignment or different assessment schemes, however, if happens only very infrequently that such a MOOC created by one particular institution for their curriculum is accepted by another institution as a ‘MOOC as a Replacement’ within their own curriculum.

In both the above scenarios, it can be observed that reusability of the MOOC in other settings is often low, as the relevant MOOCs do not cover exactly the requirements of other parties potentially interested in their reuse.

B. *MOOCs and Blended Learning Scenarios*

Most educational institutions offer courses that combine in-person and online elements. Flipped classroom scenarios are particularly popular. In such flipped classroom settings, learners prepare new content online at home and work on problem-solving activities in class. Such courses usually offer an online course on the local learning management system (LMS) of the institution, which structures courses, and delivers content and instructions to the students. Teaching and learning scenarios have evolved and institutions are interested in incorporating MOOCs into their courses via, e.g., blended learning [8] [15].

In the hybrid MOOC framework [7], we thus find two more scenarios, where MOOCs can be used as online elements in courses coupled with a high level of institutional support: the ‘MOOC as an Added Value’ and the ‘MOOC as a Driver.’

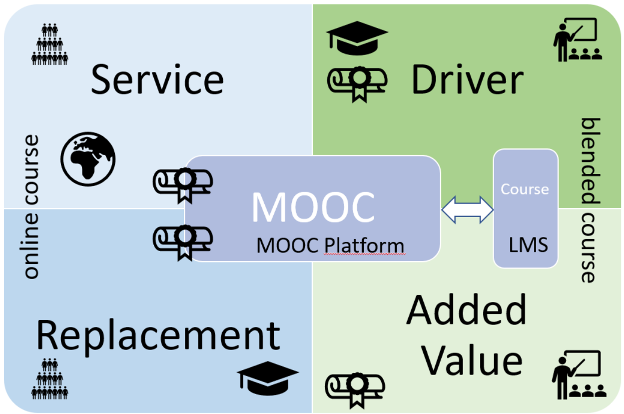

Fig. 1. The different use of MOOCs

Fig. 1 now shows an overview of the four areas of application of MOOCs described so far.

In the ‘Added Value’ and ‘Driver’ MOOC types, institutions provide infrastructure and teachers to help learners achieve success. In the former, ‘MOOC as an Added Value,’ a MOOC, which often does not align with a course of the curriculum, is reused, in order to help students acquire extra knowledge or cross curricular skills. In the second application field, ‘MOOC as a Driver’ a course in the curriculum and one or more MOOCs are either completely or partly blended.

In both of these application fields, the number of attendees is determined by the teachers or institutions, and they determine the examination modalities for the course and assess students’ performance. Both these application fields require MOOCs that are easy to re-use.

National funding agencies, who want to promote digitization in the field of teaching and learning, often demand that the MOOCs, whose development is funded, be developed in such a way that other institutions and teachers can reuse them in existing courses of their curriculum. As already mentioned above, extraneous MOOCs are often not used by these educational institutions in the ‘Service’ or ‘Replacement’ settings. However, to be able to include such a MOOC as an ‘Added Value’ or a ‘Driver’ in a course, teachers must embed the relevant MOOC into their blended course scenarios and also be able to connect it to the LMS of their own institution. This ability to blend content into their own courses enables them to re-use (parts of) external MOOCs and also to handle their own assessment scheme, motivation strategy, and their face-to-face teaching scenarios, involving their own content, individually.

However, for MOOCs to be (re-)usable in this way, they must be structured appropriately and offer clearly identifiable competencies that will be taught within the lessons and learning objects of the MOOC. Furthermore, the lessons taught in the MOOCs must be clear and self-contained and should be as loosely coupled as possible (that is, they should only require knowledge about other content of the MOOC that is strictly necessary to be able to study and understand the subject of the lesson). A reusable MOOC fulfilling these requirements can provide high direct alignment of content with existing courses in a particular curriculum without being specifically designed for that curriculum. In practice, however, these requirements are often not fulfilled, especially when MOOCs are designed for the 'Service' or 'Replacement' scenarios, inhibiting their re-use in blended classroom settings.

In the following, we will present a competence-oriented MOOC life cycle model that focusses on the development of reusable MOOCs. The criteria used in this development process can also be used to examine the reusability of MOOCS in the 'Driver' or 'Added value' settings.

III. A Competence Oriented MOOC Life Cycle

To our knowledge, research on the reusability of MOOCs in blended teaching and learning scenarios is rare and mostly refers to missing openness of educational resources [5]. Our central hypothesis is that openness of is not sufficient and the reusability of a MOOC highly depends on a competence-based structuring of the MOOC's lessons and further content characteristics. In this paper, we investigate this and offer guidance on how to create reusable MOOCs.

To this end, we developed a competence-based MOOC life cycle (MLC) model, illustrated in Fig. 2. We will show that MOOCs developed according to the MLC can be used in multiple different application scenarios (see Fig. 1). Below, we discuss each phase of our MLC model and the conditions that need to be fulfilled during MOOC development.

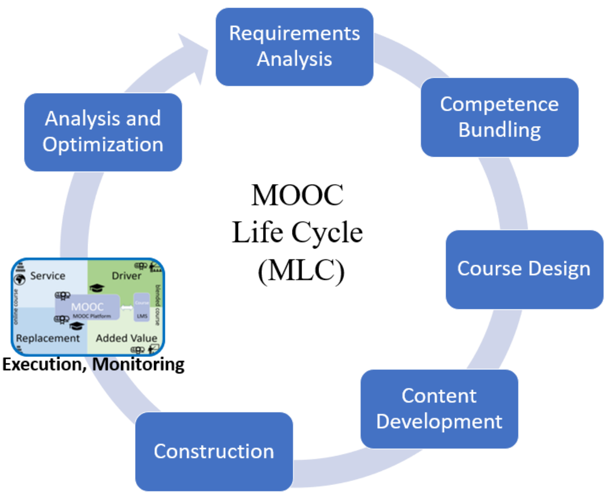

Fig. 2. The MOOC Life Cycle

In our MLC approach, we start with the **Requirements Analysis**. The goal of this phase is to look at the main motivation of the MOOC and think about what aspects and circumstances are important. This includes aspects such as specifying the subject area of the MOOC, possible platforms, the consideration of multiple learning scenarios, thinking about open licenses (a particularly important consideration when offering learning materials for re-use) and other relevant aspects like accessibility, diversity, interactivity, as well as the technical environment and implementation possibilities.

Next, the core MLC phase of **Competence Bundling** is about the definition of competencies that should be taught and the rough structure of the MOOC in the form of lessons. This phase also indirectly specifies the target audiences. We view these considerations as the most crucial part in the creation of a reusable MOOC.

To select the appropriate competencies for a given subject area, we refer to competency models to ensure that learners gain the necessary competencies to achieve success. For example, the GECKO platform [9] can be used to access competency models. In GECKO, learning outcomes of curricula, educational standards, or knowledge areas are modelled as competencies in the form of nodes. These nodes can be refined and connected to describe competence interdependencies, resulting in a directed competence. This is best done by experts in the relevant field. Fig. 3 shows nodes and their relations of an example competence model. GECKO can also be used to select subgraphs from a set of selected competencies of a competency model, which can be seen as individual views of a competency graph.

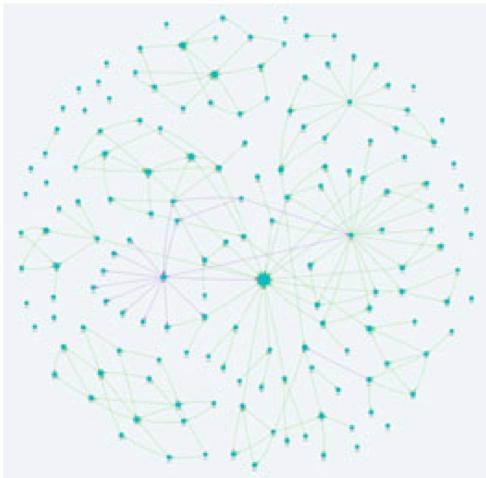

Fig. 3. Example of a competency graph

Once a competence model has been built, MOOC designers can use it for competence bundling. In GECKO, the MOOC designer can select the competencies they want to teach in the MOOC and get a MOOC-specific view of the competency graph. This subgraph includes all those competencies, which the MOOC under construction should teach, as well as the relevant prerequisite competencies that are required to participate in the MOOC.

Once the competency subgraph is created, the MOOC designer can use it to structure the MOOC into homogeneous lessons, by bundling related competencies. The first result of this process is a list of lessons that together teach the competencies selected for the MOOC. For each lesson, it now becomes clear, which competencies they teach and what competencies they require. The competencies to be taught in a lesson are sequenced according to their interdependencies. Also, the expected learning time can now be checked by the MOOC designer. Large lessons can be split up into several sequential lessons. The competencies to be taught in a lesson are sequenced according to their interdependencies in the competence subgraph selected for the MOOC.

The next MLC phase is called **Course Design**. Here, the bundled competencies (i.e., lessons) are arranged according to their level of learning taxonomy [22] and their size. Then, the results of the requirement analysis are combined with the bundled competencies in order to define the structure of the individual lessons and details like suitable sequences, interactions, etc., resulting in a set of learning objects (also referred to as modular learning units [16]), each with associated competencies that they provide or depend on, according to what role these learning objects play within their respective lesson.

During this phase also, a common look and feel of the MOOC lessons should be defined. Didactical considerations play a crucial role here, but go beyond the scope of this paper. In the Course Design phase, it is recommended to consider the associated learning taxonomy, when planning the type of learning materials (e.g., interactive videos, texts or interactive books). It is crucial to keep in mind the correspondence between competencies and planned learning objects and to make sure that learning objects do not require unnecessary or undefined competencies, as this affects the flexibility and reusability of the MOOC and its content. This combination of modular learning units, together with clearly defined competencies, is crucial to enable easy reuse in various settings later on, whether or not they are anticipated by the MOOC creators at the time of development. The output of Course Design hence is a detailed plan of the MOOC lessons, as well as the arrangement and types of the planned learning objects matching the lesson's competencies.

During **Content Development,** the planned learning objects must be developed. Alternatively, existing learning objects with compatible competencies can be re-used. Using GECKO, learning objects can also be saved together with their competencies to be re-used later.

In the **Construction** phase the MOOC is then assembled on the MOOC platform according to the Course Design. When the MOOC has been constructed, it can be rolled out into the phase of **Execution and Monitoring**. Now, the course is available to teachers and learners and can be used in different learning scenarios (as illustrated in Fig. 1). During execution, data can be collected on the use of the MOOC and via feedback from the users.

The last phase**, Analysis and Optimization**, is where the designer should check if goals are met or whether requirements have changed by analyzing the learning data and feedback. Then the MLC life cycle starts again: competencies are added or changed, which then has knock-on effects on the design and the content of the MOOC, according to the relevant MLC steps.

IV. Insights into the MLC-Development of a Database MOOC

In the following we will present examples and experiences of the authors in developing a MOOC about databases according to the MLC model [16].

A. *Requirement Analysis and Background Information*

During the first phase of the MLC the following requirements were defined for the database MOOC:

The MOOC has to be usable to accompany a database course targeted at high school and undergraduate students in computer science, but should also be suitable for other fields of study and technical schools to teach database skills. The language for the MOOC is German. The MOOC should stand out from conventional MOOCs or traditional lecture recordings. It has to follow applicable didactic guidelines, respect gender and diversity, motivate active learning, and has to work well also on mobile devices, using responsive design.

Since the developed learning materials have to be reusable, we chose to license them under the CC-BY license. We also assigned each learning object to Bloom's levels of learning taxonomy [17]. The MOOC should follow the concept of problem-based learning. It takes place in an interesting problem domain, namely solving criminal cases in a police station. A crime database (called LOKI after the god of thieves) was developed and used throughout the lessons of the MOOC. Virtual database experts teach the content and are represented by animated characters acting in an animated environment. To solve criminal cases with the help of SQL, we created a specialized tool. This tool aims to support the teaching and learning of relational databases in an interactive and engaging way in the form of adventures. These adventures can be embedded flexibly into the SQL lessons of the MOOC. The MOOC is orientated on the typical database life cycle. The learner workload for the MOOC was designed to cover approximately 60 hours learning time. We decided to use the IMOOX platform [18] to host our MOOC. During development, we will use agile project management best practices.

B. *Competence Bundling*

Based on the analyzed requirements, the next step according to the MLC was to select the competencies to be taught in the database MOOC. As far as we are aware, the knowledge area of databases has not yet been defined in the necessary detail in any existing competence models. Thus, we created a competency model for the knowledge area of databases in GECKO. This competence model was based on CS2013 (ACM/IEEE), different courses in the field of databases at our educational institution and standard literature in this field.

We used GECKO to define several competencies (e.g., 'the learner understands the objectives of databases and how databases are developed in a life cycle', 'the learner can analyze customer requirements for a database and conceptually describe a domain,' or 'the learner is able to define simple queries in SQL ') and their interdependencies, resulting in a competency graph for databases. Each area of competence was refined (see Fig. 4 for a small excerpt) and we also defined dependencies and a chronological order between the competencies. Fig. 3 shows the whole database competence model we created, which includes more competencies than we selected to be taught in our MOOC.

We then used our database competency graph to select the competencies that our database MOOC should contain and created the corresponding competency subgraph. Fig. 5 shows an excerpt of this subgraph. Given our well-structured competency graph, it was then easy to recognize clusters for in the competence subgraph, which tend to corresponded to competency areas of the competency graph (see again Fig. 4 and 5). These clusters were then bundled to identify lessons.

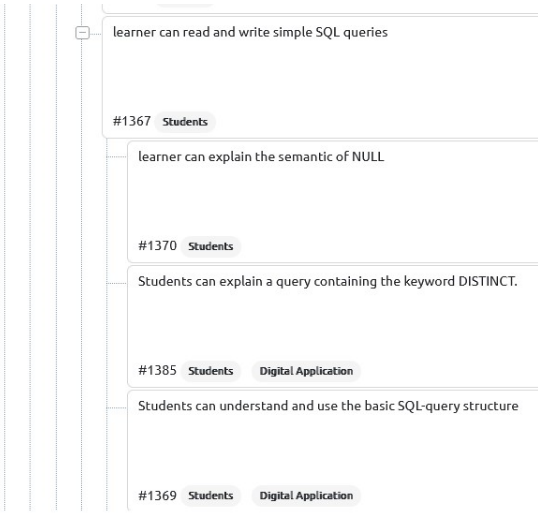

Fig. 4. Excerpt of the refinement of the competency for simple SQL

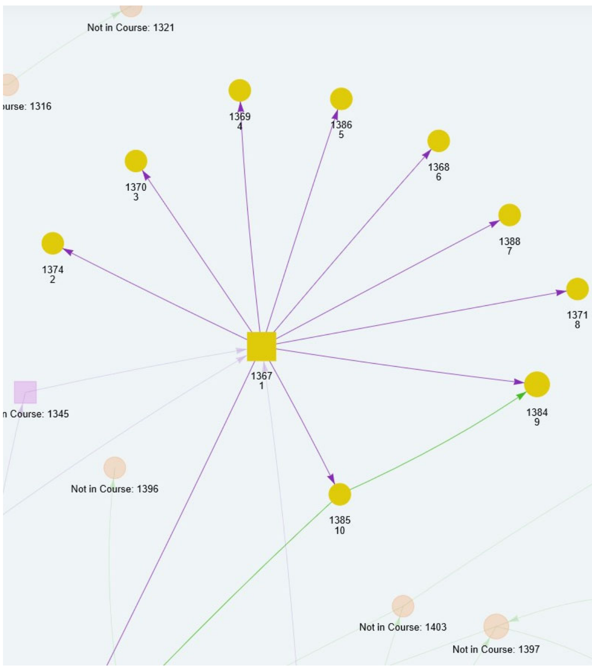

Fig. 5. Excerpt of the competency subgraph for the database MOOC

As discussed in Section III, the result of this competence bundling is a list of lessons together with the competencies that the lessons teach and a list of competencies they require.

For instance, our lesson on ‘Basic SQL’ teaches, among others, the competence ‘Learner can read and write simple SQL queries’. This requires, e.g., understanding and using the basic structure of SQL queries (cf. Fig. 5), as well as being familiar with the keywords ‘NULL’ and ‘DISTINCT’.

C. Course Design

We then arranged and refined the competencies within each lesson while considering suitable learning materials. The chosen levels of the learning taxonomy and potential types of course material were also considered. Additionally, we considered creating lesson specific texts describing goals and learning outcomes, transitional or crossover texts and other lesson elements like lesson quizzes or conclusions. The outcome of this phase was a conceptual design of each lesson, represented in table format (see an excerpt in Table 1).

Along with these considerations, we ensured that the lesson design and learning objects allow for reusability in different contexts and learning scenarios. To achieve this, we planned the lessons as modular sets of materials. The dependencies and necessary prior knowledge were represented exclusively through dedicated competencies and their relations and dependencies, enabling the simple re-use of parts of our MOOC in other applications.

TABLE I. EXCERPT OF A LESSON DESIGN

Learning object	***ID[a]***	***Level***	***Type***	***Req. time***
[Introduction]			*Text, graphic*	*2 min*
Structure of basic queries	1369	1	2 interactive videos	9 min
Managing null values	1370	1	Interactive video	4 min
Eliminate redundant results (distinct)	1384 1385	1	Interactive video	3 min
Get in line: Sorting results	1388	1	Interactive video	6 min
[Crossover text]			*Text, graphic*	*1 min*
Jeweler Robbery (story example to basic queries)	1369	2	Interactive video	4 min
Gang overview (story example to distinct)	1370	2	Interactive video	3 min
[Crossover text]			*Text, graphic*	*1 min*
Wanted: Vandal (exercise for self practice: basic queries)	1369	3	aDBenture link, PDF	10 min
…	…	…	…	…
[concluding text]			*Text, graphic*	*1 min*
[End quiz]		*3*	*Moodle quiz*	*10 min*

a. Competency IDs

D. Content Development

The next phase in the MLC was creating the outlined learning objects that suited the defined competencies. It was crucial to rely solely on the defined competencies as prerequisites and ensure that all necessary prior knowledge was actually represented via those competency dependencies. For quality assurance, the developed learning materials underwent internal reviews. In addition, relevant metadata, including the competencies, was added in order to to facilitate enhanced searchability, usage, and editing possibilities. When developing the material, didactic considerations played an important role. We tried to select interesting contexts and examples, incorporate role models and diversity, determine appropriate video durations, and include an adequate number of interactions to motivate learners’ activity (e.g., via interactive H5P elements), to name several ideas. The development process varied depending on the type of material being created. For instance, for videos, storyboards were written, followed by the design and rigging of animated locations and characters, audio recordings, video settings and cuts. To practise SQL, we developed an SQL adventure tool. The creation of quizzes also fell into this MLC phase.

E. Construction

Once all the necessary content had been developed, the course was assembled according to the design developed in the Course Design phase. However, some adaptations were made, such as refining the textual connections between learning objects or making minor adjustments to the partitioning within the lessons. Furthermore, we created lesson quizzes. Again, the defined competencies and their interdependencies remained the guiding principle.

F. Execution

Our database MOOC is to be offered as a 'Service', freely available on the IMOOX platform. Moreover, we conducted a test-run of the database MOOC as a 'Driver' with 55 students in two database courses, which belong to several undergraduate-level curricula at our educational institution. We embedded lessons of the MOOC into our blended course scenarios and connected them to our local e-learning platform. In this way, we blended MOOC lessons into established in-person courses, but conducted our own assessment schemes, motivation strategy and face-to-face teaching scenarios. Besides these two courses, we used the database MOOC as an 'Added Value'-type MOOC in two further practical database courses with another 50 students.

G. Analysis and Optimization

The possibility to analyse learning data on the MOOC platform depends on the provided data. In our case the opportunities offered by IMOOX are limited, even though we are the authors of the MOOC. Hence, we will use learning data from our local LMS (which is linked to the MOOC, which resides on our own e-learning platform) and we are also working on a questionnaire to evaluate the experience of students using the MOOC. Preliminary student feedback has been overwhelmingly positive.

V. Summary and Resumee

In this paper, we presented a novel life cycle model for MOOC development and deployment that focusses on reusability of the resulting MOOCs, or parts thereof, in various contexts. In this model, construction and analysis of a set of competencies, as well as their interdependencies, leads to well-defined learning objects that, ideally, have no dependencies on other learning objects in the same MOOC, but only on competencies that a learner must have in order to be able to successfully tackle the relevant learning object. This enables the easy re-use of the learning objects forming the MOOC, since these competencies could also be learned from a different source, i.e., not from the MOOC itself.

We gave a detailled description of our model and illustrated its use on an MOOC created to teach the subject of databases, which shows how lessons and learning objects are created that can be easily re-used in a variety of contexts since they are not strictly dependent on each other. In autumn 2023 we plan to use the database MOOC at 2 high schools with 60 students. For future work, we aim for a deeper integration of our model with the GECKO platform in order to easily organize the development of reusable MOOCs. It would also be useful to offer a software-based solution so that it is easier to follow our life cycle model, since at the moment the needed organizational steps largely have to be done by hand.

References

[1] Kovanović, V., Joksimović, S., Gašević, D., Siemens, G., & Hatala, M., "What public media reveals about MOOCs", *British Journal of Educational Technology. 46(3),* p. 510–527, 2015.

[2] McAuley, Alexander; Stewart, Bonnie; Siemens, George; , Cormie, Dave, "The MOOC Model for Digital Practice," [Online]. Available: http://davecormier.com/edblog/wp-content/uploads/MOOC_Final.pdf (Accessed: 2023-05-08).

[3] H. Alkhatib, P. Faraboschi, E. Frachtenberg, H. Kasahara, D. Lange, P. Laplante, A. Merchant, D. Milojicic, and K. Schwan, "IEEE CS 2022 Report,," *IEEE Computer Society,* pp. 25-27, 2014.

[4] Zang, X., Iqbal, S., Zhu, Y., Riaz, M. S., Abbas, G., & Zhao, J., "Are MOOCs Advancing as Predicted" in *International Conference on Systems Informatics, Modelling and Simulation (SIMS)*, 2022.

[5] Ruiperez-Valente J., Martin S., Reich J.,&Castro M.: "The UnMOOCing Process", Sustainability 2020, 12.

[6] Shah, D., "By the numbers: MOOCs in 2021.," 2021. [Online]. Available: https://www.classcentral.com/report/mooc-stats-2021/ (Accessed: 2023-05-08).

[7] Pérez-Sanagustín, Mar, et al., "H-MOOC framework: reusing MOOCs for hybrid education," *Journal of Computing in Higher Education 29,* pp. 47-64, 2017.

[8] Ebner, M., Schön, S., Braun, C., "More Than a MOOC—Seven Learning and Teaching Scenarios to Use MOOCs in Higher Education and Beyond.," in *Emerging Technologies and Pedagogies in the Curriculum.*, Singapore, 2020.

[9] Graph-based Envirinment for Competency and Knowledge Item Organization, 2023. Available: https://gecko.aau.at/en/home (Accessed: 2023-07-10).

[10] Toven-Lindsey, B., Rhoads, R. & Berdan Lozano, J., "Virtually unlimited classrooms: Pedagogical practices in massive open online courses.," *Computers & Education, 24, 1-12.*

[11] Fair, N., Russell, S. Harris, L., & Leon Urrutia, M., "Enhancing the student experience: integrating MOOCs into campus based modules" in *International Council for Education and Media, Naples, Italy.*, 2017.

[12] Gynther, K., "Design Framework for an Adaptive MOOC Enhanced by Blended Learning," *Electronic Journal of e-Learning, 14,* pp. 15-30.

[13] Holotescu, C., Grosseck, G., Cretu, V., & Naaji, A., "Integration MOOCs in Blended Courses.," in *International Scientific Conference on eLearning and software for Education*, Bucharest, Romania, 2014.

[14] Bralić, A., Divjak, B., "Integrating MOOCs in traditionally taught courses," *Journal for Educ Technol High Educ, 15(2),* 2018.

[15] Pérez-Sanagustín, M., Sapunar-Opazo, D., Pérez-Álvarez, R., Hilliger, I., Bey, A., Maldonado-Mahauad, J., & Baier, J., "A MOOC-based flipped experience: Scaffolding SRL strategies improves learners' time management and engagement.," *Computer Applications in Engineering Education, 29(4),* pp. 750-768, 2021.

[16] Dive into the world of databases (German), 2023. Available: https://imoox.at/course/Datenbanken (Accessed: 2023-07-10)

[17] Johnson, C. G., Fuller U., "Is Bloom's taxonomy appropriate for computer science?" in *Proceedings of Koli Calling 2006*, 2006.

[18] Ebner, M., "iMooX-a MOOC platform for all (universities)," in *ICEEIE* , 2021.

[19] Stracke, C. M., & Tan, E., "The quality of open online learning and education: Towards a quality reference framework for MOOCs" in *In 13th International Conference of the Learning Sciences*, 2018.

[20] Cooper, S., Sahami, M., "Reflections on Stanford's Moocs" *Communications of the ACM,* pp. 28-30., 56(2).

[21] Liyanagunawardena, T. R., Adams, A. A., & Williams, S. A., "MOOCs: A systematic study of the published literature 2008-2012" *International review of research in open and distributed learning, 14(3),* pp. 202-227.

[22] Julia, Kasch, and Kalz Marco., "Educational scalability in MOOCs" *Computers & Education 161,* 2021.