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EMOOCs 2023

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EMOOCs 2023: Post-Covid Prospects for Massive Open Online Courses – Boost or Backlash?

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Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at http://dnb.dnb.de.

Universitätsverlag Potsdam 2023
http://verlag.ub.uni-potsdam.de/

Am Neuen Palais 10, 14469 Potsdam
Phone: +49 (0)331 977 2533 / Fax: 2292
Email: verlag@uni-potsdam.de

Typesetting: Martin Sievers – Einfach schöner publizieren
Layout: Tobias Pape
Print: docupoint GmbH Magdeburg

Simultaneously published online on the publication server of the University of Potsdam:
https://doi.org/10.25932/publishup-57645
https://nbn-resolving.org/urn:nbn:de:kobv:517-opus4-576450

Contents

Impact of Mooc and Other Online Course Development on Campus Education

Selma van Esveld, Nardo de Vries, Sibilla Becchetti, Sofia Dopper, and Willem van Valkenburg

Delft University of Technology – Extension School
Landbergstraat 15, 2628 CE Delft, The Netherlands
s.l.vanesveld@tudelft.nl

The TU Delft Extension School for Continuing Education develops and delivers MOOCs, programs and other online courses for lifelong learners and professionals worldwide focused on Science, Engineering & Design. At the beginning of 2022, we started a project to examine whether creating an online course had any impact on TU Delft campus education. Through a survey, we collected feedback from 68 TU Delft lecturers involved in developing and offering online courses and programs for lifelong learners and professionals. The lecturers reported on the impact of developing an online course on a personal and curricular level. The results showed that the developed online materials, and the acquired skills and experiences from creating online courses, were beneficial for campus education, especially during the transition to remote emergency teaching in the COVID-19 lockdown periods. In this short paper, we will describe the responses in detail and map the benefits and challenges experienced by lecturers when implementing their online course materials and newly acquired educational skills on campus. Finally, we will explore future possibilities to extend the reported, already relevant, impact of MOOCs and of other online courses on campus education.

1 Introduction

With a clear mission to "educate the world and improve the quality of campus education", the TU Delft Extension School for Continuing Education works with faculties and external partners to develop and offer online courses and short learning programs to equip professionals and lifelong learners to solve today's global challenges.

Its commitment to deliver high-quality, stimulating and engaging online learning experiences that meet learner's needs is underpinned by a robust quality assurance structure at institutional, portfolio and course quality level. One of the course quality elements is providing instructors with dedicated training and intensive guidance on how to design and moderate an online course. For lecturers, this creates opportunities for professional development. The course content, openly licensed, can be used in the delivery of on-campus courses. Moreover, the adaptation of online, digital teaching skills and reuse of online resources fosters a development towards more education modernization such as open education [5]. In March 2020 the University had to switch to emergency remote teaching due to COVID-19 lockdown. To what extent did lecturers bring online course experiences and resources to their campus courses? And was this beneficial for the quality of campus education?

Our colleagues published an article on the support lecturers received during these lockdowns [8]. In the current paper, we specifically examine the impact of online course development on campus education from a lecturer's perspective. Besides mapping the reuse of materials, this article focuses on the effect on the lecturers who created an online course. In order to conceptualize the impact on campus education, we follow Desimone's conceptual framework for online professional development [4]. The mechanism to affect educational change is prompted by a) the teachers' practical experience with online professional development, b) altering their knowledge, skills, beliefs and attitudes, c) resulting in changed classroom practices, to finally d) improve student outcomes [7]. Hence, in this study, impact is operationalized as the professional development of the lecturers as well as the application of online teaching materials and eventually learner outcomes.

We describe the results obtained by surveying TU Delft lecturers involved in developing and teaching the online courses and programs of the TU Delft Extension School. Through the analysis of responses, we aim to map the benefits and challenges experienced by lecturers when implementing their online course materials and newly acquired educational skills in their campus teaching practice.

2 Online Course Development Benefits Campus Education

The online survey to collect lecturers' views on the impact of online materials on campus education was designed using Qualtrics (Qualtrics, Provo, UT) and consisted of 23 questions of the kind multiple-choice, Likert-scale, slider, or open textbox. In January 2022, we contacted all lecturers that have been involved in the development of one or multiple MOOCs or other online courses with the Extension School. These 245 lecturers were contacted by email and asked to complete the survey using an anonymous link. Participation was entirely voluntary; it was permitted to withdraw at any time and to omit answering any question. The survey data were only collected after gaining consent from the participants. For the data analysis we included the most completed latest response from each IP address to prevent multiple responses from the same lecturer. The descriptive statistical analysis was performed using the R statistical package [6].

We received 68 responses, equal to a response rate of 27.7 %. For web-based surveys this falls within one standard deviation of the average response rate of academic studies in the behavioral sciences (M = 38.8 %, SD = 15.1), and fits the norm [3]. The response rate could vary per question due to the absence of forced responses and the survey flow. In the figures in this paper, we indicated the number of respondents (n) for each question. The mean survey duration was 11 minutes per respondent, indicating that the quality of the responses was sufficient. In the following sections, we will describe the results regarding the current impact on lecturers (2.1) and on campus (2.2), and the future possibilities of increasing the use of online materials on campus (2.3).

2.1 Building and delivering an online course aided lecturers with skills and materials

A key element of the Extension School's strategy to guarantee course quality is to provide instructors with dedicated training and intensive guidance on how to design and moderate an online course. In the survey, 64 % of respondents indicated that on a personal level, the designing and delivery of an online course enhanced their professionalization and fostered the acquisition of new skills (Figure 1A). The online experience also helped 38 % of responding lecturers to redesign and rethink their campus education (Figure 1A). All these are valuable impacts for campus education.

Figure 1B shows that lecturers experienced the acquisition of improved teaching materials (78 %) as the biggest impacts (defined as having the largest fraction that indicated a moderate to major impact), followed by the availability of more educational examples (62 %) and an improvement in the overall quality of their teaching (60 %). We expected results to show that lecturers would spend less hours on preparing class materials when they could reuse their online materials on campus. A previous study also reported that one of the main reasons for teachers to reuse resources is efficiency (time gain) [2]. However, most instructors in the current study do not report a large positive impact on this aspect (Figure 1B).

If lecturers indicated a major impact in Figure 1B, they were asked to elaborate on the experienced impact. The elaborations for example specify major impact on new organization or format for campus teaching (n = 8), more diverse learning materials (n = 5) and enhanced educational transferable skills (n = 4). One of the remarks often mentioned is that the developed online materials and the acquired skills and experiences were especially beneficial during the transition to online/remote teaching due to the COVID-19 lockdown periods.

Did the incorporation of online material always lead to improved campus education? Although 60 % of lecturers indicated that the quality of their teaching improved (moderate to major impact), others indicated in open text boxes that the teaching quality reduced, the workload increased and/or that passing rates went down. These discrepancies indicate that lecturers might need support on how to implement online resources to achieve better results on campus and to prevent lower passing rates.

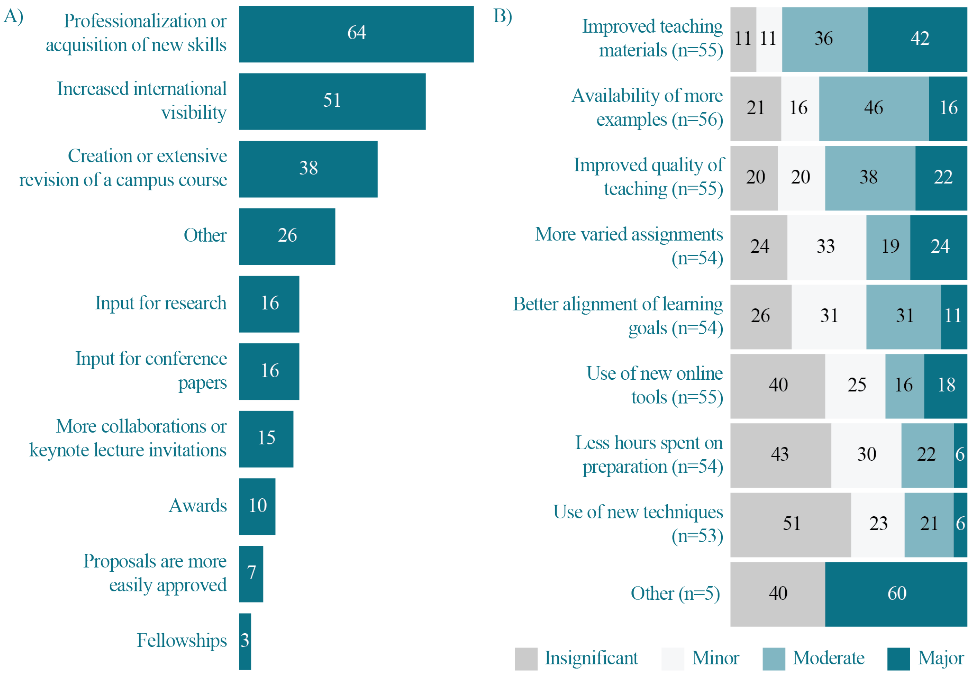

Figure 1: Building and delivering an online course aided lecturers with skills and materials. The figures show the impact of building and delivering an online course on a personal level (A, n = 61) and in general (B, n is indicated in the figure). The percentage of lecturers selecting an answer is indicated in the bars, multiple answers could be selected by one lecturer in Figure 1A.

2.2 Materials built in online courses are reused by lecturers in their class education and benefit campus students

Most responding lecturers (82 %) reuse online resources in their campus education. Videos (93 %) and quizzes (56 %) are reused most often, followed by case studies and self-assessments (both 27 %) (Figure 2A). About 60 % of the lecturers who reuse videos indicate that they reuse at least half of all the videos from their online course on campus. In line with a previous study [2] that shows that more than ten different types of on- and offline materials were reused by teachers, Figure 2A shows an extensive list of reused materials, including interactive PDFs, examples from online course participants, peer reviews, games, simulations, VR environments and online labs.

The online resources were predominantly reused in Master courses with 75 % of lecturers who reuse materials reporting reuse at this level. This is followed by Bachelor level courses with 50 %, and by pre-university/bridging level courses with 5 %. The median class size indicated by the lecturers was 100 students. These students were given access to the resources in various ways with the largest group of instructors (55 %) providing the materials through the university LMS Brightspace. The resources were integrated in their campus courses by 70 % of the responding lecturers, mostly as preparation before class.

Figure 2B shows that 83 % of lecturers indicated a moderate to major overall benefit for students. Diving into this benefit in Figure 2C, we see that 69 % of lecturers noticed a moderate or major impact with regards to an improved learning experience for the students. This is followed by 49 % who noticed better engagement face-to-face in class. Although a large fraction reported an improved learning experience, we see that especially the fraction noticing "major impact" is lower on "better students' output in any format" (12 %) and on "increased knowledge transfer by higher student answers" (15 %). This indicates that getting the best knowledge transfer when using online resources is possible as 12 %–15 % indicate a major impact on improved outcomes, but that other lecturers do struggle with getting better output from students while implementing online resources with improved learning experiences (Figure 2C).

Did the development of online course(s) only benefit the involved lecturers and their campus courses? From the survey results we can conclude that this is not the case. Although most instructors (56 %) indicated that they are not aware of their materials being reused, a large fraction (44 %) reported to be aware of the reuse. From answers in the elaboration box related to this question, we deduced that some lecturers know of instances of reuse within TU Delft during lockdown, both to replace guest lecturers, and to fill in the course gaps that arose due to the sudden move to online teaching. A few reported to know of instances of reuse by other universities and organizations.

How about the reuse of online materials on campus that were created by others? Only 30 % of responding lecturers reuse online resources from others. In the elaboration box we read about incorporating materials by TU Delft colleagues as well as from other universities. These materials are varied: talks/lectures, videos (including lab videos and short movies), documents, reference images, calculation tools, and Miro boards. The main reason mentioned by the 70 % who do not reuse materials by others is the lack of those materials in the field of interest or the lack of a good overview of what is available.

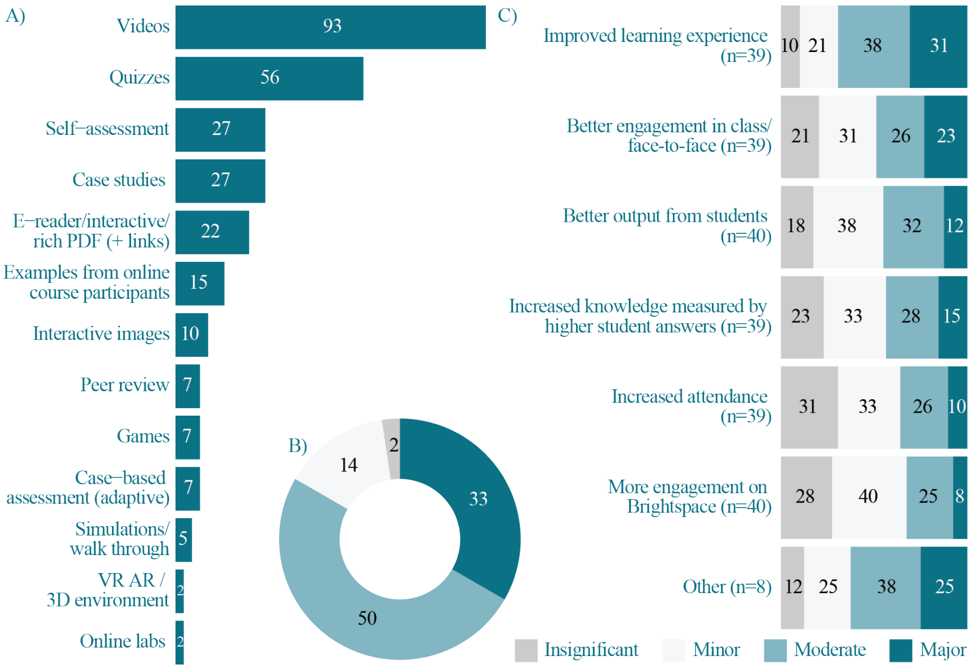

Figure 2: Materials built in online courses are reused by lecturers in their class education and benefit campus students. The percentage of lecturers selecting an answer are indicated in the bars. **A)** Responding lecturers (n = 41) indicated one or multiple resources from their online course(s) that were reused on campus. **B)** Overall benefit of using the online material for campus students according to the responding lecturers (n = 42), legend depicted in the figure. **C)** The figure shows the impact that responding lecturers (n is indicated in the figure) noticed on students. Same legend as Figure 2B.

2.3 Increasing the reuse of online educational resources into campus education requires appreciation, recognition, and support

Lecturers also reported constraints in the incorporation of online resources into campus education. These constraints mainly involve time limitations; perceived differences in the academic level of online and campus courses; the availability of suitable material; a lack of support by management; and the potential negative perception by students or peers. Suggestions on how to implement online resources to achieve better results by further extending the already relevant impact of online education on campus, include appreciation, recognition and support by management, and a searchable database to promote and facilitate reuse.

3 Conclusion

This survey project mapped the benefits and challenges associated with the impact of online course development on campus education. An advantage of the approach is the ability to collect both quantitative and qualitative feedback from a group of 68 lecturers involved both in online and campus education. The results showed that developing an online course with the TU Delft Extension School was beneficial for campus education in at least two ways. First, lecturers could implement the universal skills acquired during the online course development process on campus education. The online development inspired them and potentially made them better equipped to redesign and rethink campus education. As a second perspective, the reuse of online materials on campus, was reported to be beneficial for students as well as for the instructors creating the campus course.

While the above two ways lead to a general valuable impact, the acquired skills and reusable material turned out to be especially beneficial for campus education in the last years. They facilitated the transition to online teaching and learning during COVID-19 lockdowns for our responding online instructors. This is in line with a report on blended learning during the COVID-19 pandemic on Open Educational Practice (OEP) – whereby staff and lecturers share, contribute to, and reuse materials with an open license and openly collaborate, discuss, and brainstorm – was reported to be supportive for emergency educational shifts [8]. A large fraction (44 %) of lecturers reported to be aware of the reuse of their online resources by others mostly on campus, but some also reported global reuse. This showcases that the online development process results in Open Educational Resources (OER).

However, of the surveyed, online experienced lecturers only 30 % reused materials created by others, meaning that they still experience barriers or do not want to implement OER created by others. These barriers are probably even higher for lecturers who are not involved in online education themselves. According to the canvassed lecturers who are involved in both online and campus education, further extending the campus education impact requires several factors. Main reported factors were: providing lecturers with support on how to reuse online resources to achieve better results with students; clear appreciation, recognition, and support by management; and the availability of a searchable database to facilitate reuse of materials. Searching and evaluating resources were also indicated by previous studies (e.g. [1]) to be barriers for OER reuse.

To reach the entire potential impact of open education on campus, all lecturers should have the time and skills to access, adapt and use online OER. Lecturers who are not themselves involved in online education might need other types of support to implement more online resources in their campus teaching.

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Preparing for Society 5.0 with MOOC Capabilities Extension

An industry-academia collaboration on learning analytics dashboard development

May Kristine Jonson Carlon[1,2], Kensuke Yokoi[2], John Maurice Gayed[3], Hiroshi Suyama[2], and Jeffrey Scott Cross[1]

[1] School of Environment and Society, Tokyo Institute of Technology
Ookayama, Meguro-ku, Tokyo 152-8550 Japan
mcarlon@acm.org,cross.j.aa@m.titech.ac.jp
[2] Wisdom Inc.
Akebonocho, Tachikawa-shi, Tokyo 190-0012 Japan
{k-yokoi,suyama.hiroshi}@wisdom-inc.jp
[3] Waseda University
Totsukamachi, Shinjuku City, Tokyo 169-8050
gayed@waseda.jp

Academia-industry collaborations are beneficial when both sides bring strengths to the partnership and the collaboration outcome is of mutual benefit. These types of collaboration projects are seen as a low-risk learning opportunity for both parties. In this paper, government initiatives that can change the business landscape and academia-industry collaborations that can provide upskilling opportunities to fill emerging business needs are discussed. In light of Japan's push for next-level modernization, a Japanese software company took a positive stance towards building new capabilities outside what it had been offering its customers. Consequently, an academic research group is laying out infrastructure for learning analytics research. An existing learning analytics dashboard was modularized to allow the research group to focus on natural language processing experiments while the software company explores a development framework suitable for data visualization techniques and artificial intelligence development. The results of this endeavor demonstrate that companies working with academia can creatively explore collaborations outside typical university-supported avenues.

1 Introduction

Unlike outsourcing which focuses on reducing the costs of the client and the contracted party solely fulfills its contractual obligations, collaboration is more of an investment where the parties involved all seek to benefit from the partnership. Aside from the completion of a common project, collaborations can contribute to organizational learning and be a catalyst for innovation [1]. At Tokyo Institute of Technology (Tokyo Tech), academia-industry collaboration programs include company-sponsored research, accommodation for visiting researchers, consultations, and collaborative research, among others. Each of these partnerships regards one party as a provider of some sort; it may be a company funding an activity, or the university sharing its know-how.

Working on the assumption that companies will finance projects while universities make discoveries will potentially limit opportunities for small-to-medium scale industries with less capital for technological diffusion. In Japan, it was found that industry funding is not as efficient as competitive grants in generating inventions; but inventions from competitive grants find it tough to see widespread use [8]. As such, it is important to increase academic researchers' proximity to the industry – one way is to creatively seek collaboration opportunities by thinking beyond the well-established university infrastructure.

In this paper, a collaboration between a company and a university laboratory is discussed. The goal of the collaboration is for the company to build visualization skills using a technology set they have not previously used, and for the laboratory to speed up the web browser development needed for its research. The motivation behind the collaboration is first discussed in section 2, followed by what is already known before the collaboration that can help each interested party achieve their goal in section 3. The novelty in this work is highlighted in section 4, where the interested parties' relationship is that of equal footing and not benefactor-beneficiary, which is common in such collaborations, is clarified. The current status of the collaboration is described in section 5, where the eventual benefits for both parties are presented.

2 Motivation Behind the Collaboration

In 2016, the Japanese government laid out goals for achieving a "Super Smart Society" or Society 5.0, which pushes industries and universities to "establish a systemic virtuous cycle of human resources, knowledge, and capital for innovation [2]." In 2020, the Cross Lab at Tokyo Tech received a competitive grant for research that involves the creation of a learning analytics dashboard (LAD).

2.1 Japan's Society 5.0

A popular way of summarizing human socioeconomic evolution is by dividing human history into "ages" based on significant transformations that were introduced: for instance, the transformation of materials for the Stone and Agricultural Ages [7]. The Industrial Age, or transformation of industries, is seen to be composed of several revolutions where huge innovations are introduced: the first with machinery, the second with technologies such as railroads, the third with digitalization, and the fourth with automation [10]. However, many consider the Third and Fourth Industrial Revolutions to be introductions of not mere innovations but of transformation: the transformation of information, thus receiving the label "Information Age".

Following the four previous "societies" – Stone, Agricultural, Industrial, and Information – Japan anticipates the birth of Society 5.0 [2]. In this new age, a transformation is expected to occur in how humans interact with physical space and cyberspace. In the education field, Society 5.0 will most likely materialize from the availability of big data, partially spurred by the proliferation of massive open online courses (MOOCs).

2.2 Learning Analytics Dashboards

LADs are interfaces showing multiple data visualizations aimed to provide information about learning experiences. The creation of LADs for MOOCs is attractive due to the availability of multimodal data that become more valuable to the learning experience after analysis and visualization. LADs have been instrumental not just in giving performance feedback but in providing motivation that is crucial to self-regulated learning [6], which in turn leads to better outcomes in online learning environments. With the availability of global data from MOOCs that attract learners around the world, LADs can even potentially be conduits for alleviating justice, equity, diversity, and inclusion concerns through more critical user need analysis and cross-border collaborations [12].

3 Prior Work

To stay abreast with the aforementioned trends, it is imperative to be conscientious in building research software and fostering continuous learning in the workplace.

3.1 On-the-job Skills Acquisition Strategies

On-the-job skills acquisition can be thought of as at least any of the following [9]:

- **New hire training** where new members of the company (including interns) receive orientation associated with the roles that they would be assuming in the company,
- **Project-based training** where a team picks up a skill to fulfill the requirements of their projects,
- **Upskilling** where an employee develops new skills related to their job for upward mobility in their career, and
- **Reskilling** where new skills are acquired in anticipation of significant changes in the workplace such as digitalization or automation.

Aside from reskilling, all of the above is somewhat commonly encountered in workplaces. However, reskilling is crucial for any company to remain competitive: in 2022, about a third of the anticipated essential skills for 2025 are not yet considered to be crucial [9]. With such a quick pace, reskilling efforts such as in this endeavor described in section 4 is more of a requirement than an option.

3.2 Personalized Online Adaptive Learning System (POALS)

POALS is a web-based system designed to help learners succeed in online learning environments. An overview of the system made up of three components – Metacognitive Tutor, Adaptive Engine, and Analytics Dashboard – is seen in Figure 1.

Metacognitive Tutor Metacognition, colloquially defined as "thinking about thinking," is essential to succeed in online learning environments. An existing metacognitive tutor was adapted to be more optimized and usable for online use, which is now POALS' Metacognitive Tutor. However, while the participants in the experiments rated the tutor to be usable and improvements in cognition regulation are observed, there is no clear indication that the tutor helps to achieve better learning outcomes [5].

Adaptive Engine The Metacognitive Tutor's lackluster results could be due to metacognitive training on top of cognitive learning straining the learners' cognitive resources. POALS' Adaptive Engine was envisioned to investigate cognitive adaptive learning for the Metacognitive Tutor [3]. Through initial investigation for Adaptive Engine, it was seen that models using metacognitive inputs performed better than the standard models while still following learning intuitions.

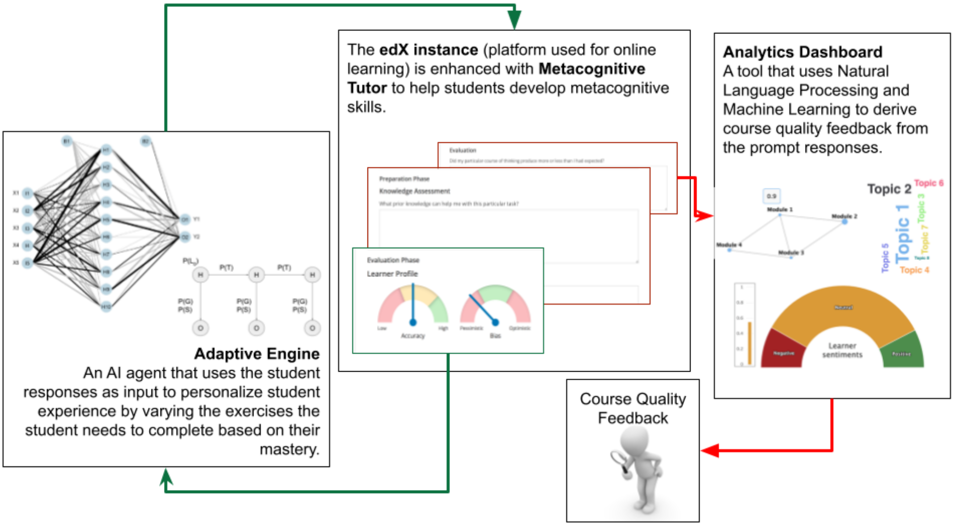

Figure 1: POALS overview.

But before fully implementing the Adaptive Engine, other issues surrounding it such as explainability will still need to be investigated.

Analytics Dashboard Finally, POALS' Analytics Dashboard is a visualization tool based on various natural language processing (NLP) techniques that serve as the teacher's window to their learners' implicit feedback. Learner inputs on the Metacognitive Tutor are used for the analysis. The proof-of-concept shows an aggregate of tools the teacher can use to understand learner sentiment, diagnose possible misconceptions, and check learning retention [4].

4 The Collaboration Project

With the current advancements in NLP research, it was determined that exploring the Analytics Dashboard's potential could be worthwhile. This collaboration project is between Wisdom Inc., a small-to-medium sized company in West Tokyo specializing in web and enterprise software and Cross Lab who had been working on MOOC-related research through their relationship with the Online Content Research and Development section under the Center for Innovative Teaching and Learning.

4.1 Project Organization and Learning Goals

As a company that has gained the trust of its Japanese clientele not just with development work but with business know-how as well, Wisdom Inc. is looking forward to learning new technologies that can be easily aligned with Japan's Society 5.0 goals. This includes web frameworks that can easily integrate with computational tools important for artificial intelligence development. Visualization techniques are also crucial especially as big data becomes more and more prevalent.

Cross Lab, on the other hand, is ramping up its personalized learning research. Aside from developing its research competency, it is imperative for the group to create a research ecosystem that not only allows for more research to happen but can also translate meaningful research outputs to practice that the public can benefit from. POALS is envisioned to be one such system.

In this project, Wisdom Inc. is improving the Analytics Dashboard while learning new technologies associated with a more computational-ready programming language and a data visualization library. This supports Cross Lab in building a long-term research project.

4.2 Improvement Points for the Analytics Dashboard

The Analytics Dashboard relies heavily on the Metacognitive Tutor for its input, but experiments using the Metacognitive Tutor did not indicate optimal results [4]. The preliminary studies on the Analytics Dashboard have promising results though, hence its development is worth continuing. Another difficulty is that as a Japanese institution, Tokyo Tech creates courses in both English and Japanese. Different languages will require different NLP techniques. Also, aside from edX.org, Tokyo Tech uses other LMS such as Moodle and Canvas for small private online courses (SPOCs). Of course, sharing POALS with other researchers working on MOOCs is of interest. Finally, the Analytics Dashboard is static and does not provide the teachers the opportunity to interact with the analysis. To address these concerns, the Analytics Dashboard was first modularized to separate the user interface from the data management and the data analysis. This modularization is illustrated in Figure 2 with each component described below.

Data Importer Instead of learner inputs from the Metacognitive Tutor, posts from discussion forums will be used for the Analytics Dashboard. edX.org has edX Data Package where various data associated with the learning management system (LMS) are collected, including forums database exports. POALS is created with the Python web framework Django, hence scheduled tasks importing data from LMS to the POALS ecosystem are managed with the task queue and

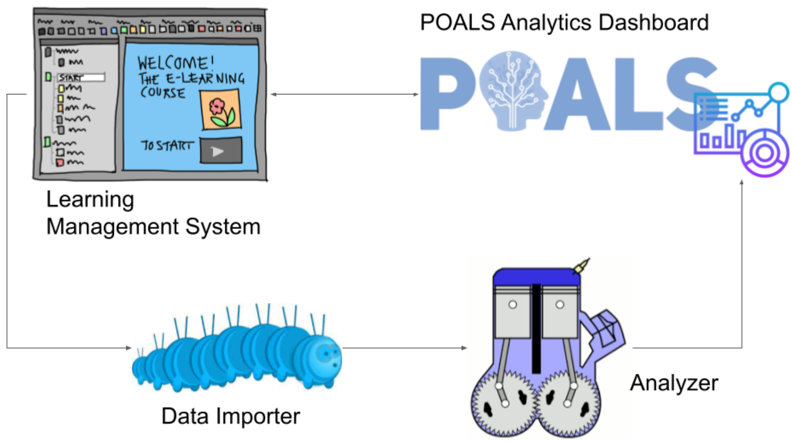

Figure 2: Modularization of the POALS Analytics Dashboard. Images from Pixabay, Publicdomainvectors.org, Flaticon, and Wikimedia Commons.

scheduler, Django Q. Aside from discussion forums, other text data such as course content may also be imported into the system.

Analyzer The NLP-based analysis from the original Analytics Dashboard is kept. Previous source codes associated with NLP processing are converted instead into a Python package. This allows researchers to test out their analyses in Jupyter notebooks and the like using their test data and making changes to the package as they see fit. This benefits the collaboration as the company can continue with the web application development without disrupting the ongoing research.

Dashboard The Analytics Dashboard's visualizations are created with Highcharts, a JavaScript library. With this, the teacher can have an idea of their learners' feelings and understanding of the lessons granted the resulting analytics is straightforward. However, automatically generated information may not be easily understandable, requiring the teacher to look into the summarized data's details and possibly make configuration settings. This is made possible in the new Analytics Dashboard as discussed in subsection 5.1.

5 Current Status

Collaboration talks started as early as December 2021, though the bulk of the work involved with the project peaked in February 2023. While the software itself is close to completion, the associated research is expected to continue. Further collaboration might be considered depending on the research progress.

5.1 The Improved POALS Analytics Dashboard

A sample user interface of the main dashboard is shown in Figure 3. Each of these parts is discussed in the succeeding paragraphs.

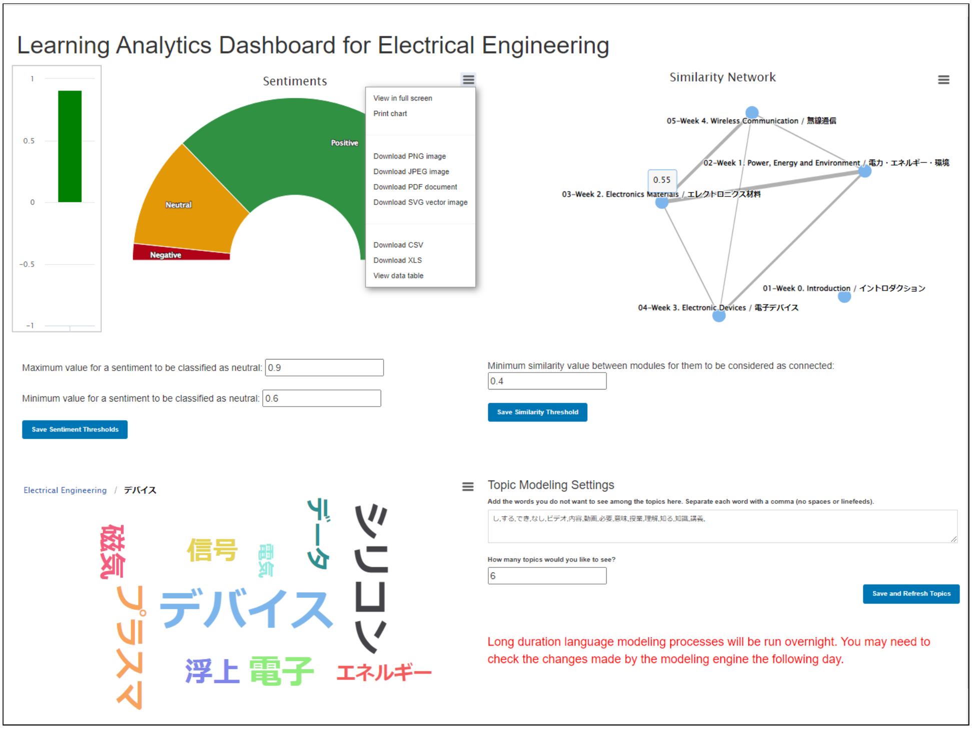

Figure 3: Sample user interface of the new dashboard.

Sentiment Analysis The Analytics Dashboard presents sentiment analysis in bar and donut charts, as shown in the upper left corner of the screen. The bar chart shows the overall class sentiment (higher scores generally mean more positive learners). A donut gauge shows the percentage of negative, neutral, and positive responses. This feature had been present in the original Analytics Dashboard.

In this updated version, the posts in the discussion forums are used instead of the learner responses in the Metacognitive Tutor. Aside from the change in the analytics source, clicking the bar chart will now display a line chart of average weekly sentiment scores in a modal dialog. Clicking on the donut chart will show the text data and the sentiment scores in tabular form. The teacher can adjust the sentiment score as they see fit. After manually editing the sentiment score, the chart values are immediately recalculated and redisplayed. Depending on the configuration, a new sentiment model will be trained asynchronously to use the updates made by the teacher. This allows us to anticipate problems posed by model drift, or the degradation in the model's ability because of the changes that have happened in its environment.

Text Similarity In the upper right corner of the Analytics Dashboard, a similarity network is displayed with a node for each course module. Hovering over a module will show the average learner score for that module. Similar modules based on some threshold value are connected by lines, and the degree of similarity between the modules is indicated by the thickness of the line (the thicker the line, the more similar the modules). This similarity is calculated based on the words used in the modules, including those in video transcripts, text on quizzes, and others. This visualization is useful for diagnosing when learners start forgetting important information in previous modules. This is also a feature that already exists in the original Analytics Dashboard.

In the updated version, teachers should be able to determine the similarity score threshold for connecting modules. Changing the threshold will immediately change the display. Clicking on a node will show a histogram of the grade data for that module.

Topic Modeling At the bottom of the Analytics Dashboard, the topics most frequently mentioned by the learners are displayed in a word cloud. Knowing which topics learners talk about can indicate which topics stick with them. If the class performance in a module associated with a topic displayed is generally good, then there is a good reason to believe that the topics are well understood. If a topic that appears in the word cloud is related to a module where the average score is low, then the module may have been misunderstood by learners. Just like the sentiment analysis, the topic modeler uses the learner inputs in the Metacognitive Tutor in the original Analytics Dashboard.

Likewise, the information source for the topic modeler was changed to the discussion forum posts. Additionally, clicking on a topic will show another word cloud corresponding to the clicked topic, thus allowing drill-down analysis. Also, the teacher can change the number of topics the same way they are able to change the words to be ignored during modeling in the past. A message informing that the changing configurations will require model training that can take time to be completed will be displayed.

5.2 Learning Reflections

During the entire time of this collaboration, the Tokyo government has maintained its encouragement to businesses to be prudent about their work practice in order to avoid the spread of the coronavirus while working towards a new normal. In response to that, Wisdom Inc. has mostly maintained its remote work practices. This enabled the new hire assigned to this project to practice independent learning through official Django tutorials in Japanese. The new hire and the researcher have also conducted regular online live coding sessions to augment independent learning. The focus is not just on completing the software but to gain confidence in the learner's new technological know-how. This also helped in building the researcher's mentoring skills.

The learning actually started even before the bulk of the work started. Members at the mid-level learned from their seniors how to establish rapport with new business partners. Everyone on the team also learned about the intricacies associated with academia-industry collaborations in terms of bureaucracies. There were also several opportunities to learn from both sides about their respective endeavors outside the project being established. More interestingly, even though both sides have considerable multicultural experience, this collaboration still introduced novel experiences on that front. This allowed Wisdom Inc. to interact with non-Asian nationals and Cross Lab to be more bilingual (English/Japanese) in their operations.

6 Conclusion and Future Work

The POALS Analytics Dashboard was updated by Wisdom Inc. to allow the Cross Lab to have a system ready for further NLP-based research with MOOC data. This has been a valuable opportunity for the company to learn technologies making them more prepared for Society 5.0 demands and for the lab in creating software that can potentially be used outside controlled experimental environments. This unique collaboration, where both parties are relative novices in the roles they are assuming, can be an inspiration for other companies and research groups who are looking to expand their current set of capabilities but may be hindered by less capital, may it be financial or social.

Testing and development are expected to continue until June 2023. The use of the Analytics Dashboard may be considered initially for SPOCs in 2024 after user research. Equally important is objectively analyzing the success of this collaboration [11].

Acknowledgment

This work was supported by the Japan Society for the Promotion of Science (JSPS) via the Grants-in-Aid for Scientific Research (Kakenhi) Grant Number JP20H01719. It is also partially funded by the donation from Wisdom Inc. to Cross Laboratory of the School of Environment and Society, Tokyo Institute of Technology. We would like to extend our thanks to those who also supported this work in one way or another: Jake Cross, Shinichi Nagara, Alethea Carampel, Seiji Mitomi, and Makoto Dodo.

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“One video fit for all”
Game inspired online TEACHING in mathematics in STEM education

Tonje Jin

Norwegian University of Science and Technology
Teknologiveien 22, Gjøvik, Norway

Online learning in mathematics has always been challenging, especially for mathematics in STEM education. This paper presents how to make “one fit for all” lecture videos for mathematics in STEM education. In general, we do believe that there is no such thing as “one fit for all” video. The curriculum requires a high level of prior knowledge in mathematics from high school to get a good understanding, and the variation of prior knowledge levels among STEM education students is often high. This creates challenges for both online teaching and on-campus teaching. This article presents experimenting and researching on a video format where students can get a real-time feeling, and which fits their needs regarding their existing prior knowledge. They have the possibility to ask and receive answers during the video without having to feel that they must jump into different sources, which helps to reduce unnecessary distractions. The fundamental video format presented here is that of dynamic branching videos, which has to little degree been researched in education related studies. The reason might be that this field is quite new for higher education, and there is relatively high requirement on the video editing skills from the teachers’ side considering the platforms that are available so far. The videos are implemented for engineering students who take the Linear Algebra course at the Norwegian University of Science and Technology in spring 2023. Feedback from the students gathered via anonymous surveys so far (N = 21) is very positive. With the high suitability for online teaching, this video format might lead the trend of online learning in the future. The design and implementation of dynamic videos in mathematics in higher education was presented for the first time at the EMOOCs conference 2023.

1 Introduction

Receiving real-time questions and feedback from students is the key element to maintain interactivity during a lecture [12, 4, 2]. This is also a positive part of the conventional teaching that needs to be preserved, especially for STEM subjects such as mathematics, in which a good understanding of the previous step can affect the understanding of the subsequent steps [27]. The ability to ask questions in real-time is one reason why live-streaming lectures are more engaging than watching pre-recorded videos [21]. The video format that is presented in this article is that of dynamic branching videos which give the students an opportunity to be simultaneously interactive with the instructor and create a feeling of live-interactive lectures with least possible distracting elements. A branching video is a type of interactive video that allows students to make choices and decisions that determine the direction of their learning, creating a more personalized and engaging experience. In this case, the students can click on an info button appearing on the screen at certain points in the video if they need more detailed explanations.

The use of dynamic branching videos for STEM education has not yet been much researched. Mainly, film producers and commercial prosecutors have been conducting this method to some degree to engage customers. But this should also be considered as an innovative method to engage students in lectures.

As presented in this article, this video method was implemented for a class of engineering students in a Linear Algebra course in a STEM study program.

The course itself requires a high level of prior knowledge for the students in order to get a good understanding. Due to the large variation of the prior knowledge in mathematics among the students, it can be challenging for the teacher to provide a lecture that can fit every student. The benefit of live lectures is that students will have the possibility to ask questions if they need some recap of the necessary prior knowledge in order to follow the subject. But once the teacher recaps the prior knowledge for one student, it might cause all the other students to feel that they waste time on recapping content they already know well. Some students might also find it uncomfortable to admit their lack of prior knowledge in front of the other students.

With the dynamic branching video that is presented in this article, the students will experience the feeling of live interaction. The total length of the video will vary from student to student depending on the amount of recap that they need.

There are two key elements in this video format. One is the suitable interactive elements that are provided by dynamic branching videos, and the other is the fundamental video footage where the teacher is visible along with the content.

2 Literature Review

There have been several studies and works published on the use of videos in online education. Many of these focus on the length and the content of the videos, and how it affects online teaching and learning, see e.g. [5]. In many cases static videos contain long monologues, making the students act as passive learners. The lack of interactivity compared to the on-campus live lectures is not beneficial to the student engagement [24].

To make the online lecture more engaging, there are several central pedagogical aspects that are relevant. One aspect concerns the way the base of the video is set up, for instance from the recorder's aspect. We consider the effect of visibility of the instructor, the use of gestures, and the effect of eye contact from the lecturer. Furthermore, we consider the importance of these aspects for cognition and learning in general and more particularly in which way they are implemented and used in online teaching. How to interact with students, so that they can receive a more suitable lecture and being more engaged is the focus of this article. We also take into consideration the content and length of the videos to make it easier for students to get engaged and focused [18, 26].

2.1 Visibility of instructor and gestures

The presence of the instructor's face in video lectures has been documented to have an affective benefit among students [17, 23]. The instructor's visibility in online lectures makes it possible to provide social cues like face expressions, gestures and other body language, as well as providing eye contact, thus maintaining a traditional classroom feeling for the students [7, 19, 8]. Such types of video presentations have been studied and found to improve the perceived social presence and at the same time reduce the cognitive load as compared to more traditional video lectures in which the instructor's face was present in a separate window, or just using voice-over [16].

The effect of embodiment has been particularly demonstrated in mathematical cognition. This was investigated in detail in a study presented in [3]. In this research, three types of gestures were studied that "manifest the embodiment of mathematical knowledge", namely pointing gestures, representative gestures, and metaphorical gestures. Each of these may contribute to improved visual perception for the students.

According to [3], by using pointing gestures, the instructor connects the spoken content and the associated mental processes to the physical content shown on the blackboard. This will reduce the cognitive load for the students and thus aid their comprehension and learning. With the innovative digital teaching techniques

"Teach Us", the teacher will appear in the same window as the content and create an eye contact feeling for the students while teaching which makes it more engaging for the students [25, 11, 13]. The method is shown in use in Figure 1.

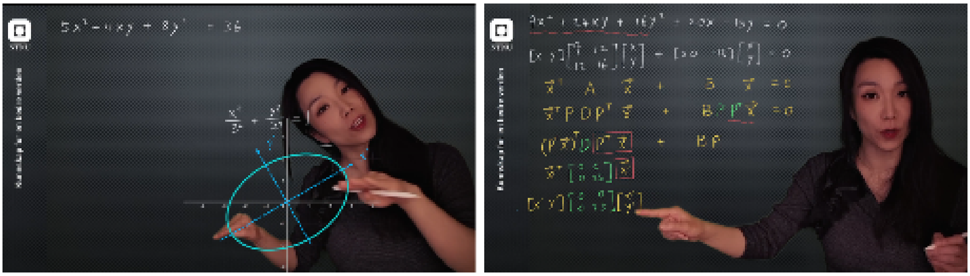

Figure 1: Examples TeachUs

2.2 Interactive elements in lectures

There has been various research on interactive videos, e.g. videos where students can write comments or questions that are attached to the timeline, which make it easier for the teacher to find where in the video the question was asked [15], or more commonly where the interactive elements will pop up in the video either by the choice of the teacher or the students. This extra content can be, e.g. additional information or quizzes during the video [20, 14]. Such interactive additions are meant to increase student engagement. According to the research, these measures did increase student engagement compared to static videos [22, 1]. This of course somewhat depends on how well the teacher has planned the video and pop-ups. In some cases, it might instead create more distractions.

In addition to the interactive elements in the video to maintain the students' focus and engagement, the length of the video content has also been investigated in previous studies [5, 20, 22].

For example, a study carried out by Carmichael et al. (2018) [6] shows elements that make education videos successful for students to gain the intended learning outcomes across disciplines. They found that shorter videos or segmentations on a longer video are beneficial, and the videos that include the teacher's image are more engaging. This way the videos might affect student motivations, confidence, and attitudes positively. Flipped classroom is given as an example of usage of the videos.

3 Methodology

3.1 Participants and feedbacks

The original testing group for dynamic videos was online students. But since we have a small group of online students this year, we are also allowing some of the on-campus students to participate.

The students signed up to participate in the video project by submitting their university email in an anonymous survey. For online students, information about this survey was sent to them via email along with the course evaluation for the Linear Algebra course. While for on-campus students the link for the survey was only provided during a 15-minute break between two lectures. So only the students who were on campus in the class that day got the opportunity to sign up. In total, around 40 students in the Linear Algebra class signed up for this dynamic video project.

The link for the dynamic video was only sent to students who signed up for this video-project, and these students were asked to answer an anonymous survey after they had watched the video. The surveys were made in Microsoft Forms, and the link for the survey is displayed as a QR-code at the end of each dynamic video.

The 4 questions asked in the survey were:

1. What do you think of this video format compared to other interactive videos you have seen? (choose one or more alternatives)
   a) It is more suited to my learning needs
   b) I achieve a better learning outcome and feel more concentrated
   c) I have not seen any other interactive educational videos before
   d) Other (describe/explain)
2. I feel that I have achieved a better understanding of conic sections after having watched the video (Likert scale 1–5, where 1 is completely disagree and 5 is completely agree)
3. I am satisfied with this video format (Likert scale 1–5 where 1 is completely disagree and 5 is completely agree)
4. Do you have any other thoughts or suggestions?

The students were also interviewed orally for additional feedback on the dynamic videos. These interviews were carried out during the digital interactive classes in Microsoft Teams for online students, and during breaks between the lectures for on-campus students. They were asked what they think about the branching videos in general, what they liked about the new video format compared to the other mathematics-related video formats they have seen before, and about any suggestions for improvements.

In addition to the student groups, the author and a team of three members with key competence for this project were gathered both for the purpose of the quality of the dynamic videos, and as participants to give constructive feedback – one physics associate professor who has over ten years of experience in online teaching, one digital media designer with long experience in videos and graphics and one chief engineer with wide knowledge in video related hardware.

3.2 Three milestone phases

The video project was divided into three phases with a timeline.

Phase one: the first round of dynamic videos and surveys for engineering students in March 2023.

Phase two: the second round of dynamic videos and surveys for engineering students in May 2023

Phase three: a larger scale of dynamic videos with a larger group of economic students in autumn 2023.

Video topics in phases one and two were chosen by the students through an anonymous survey. The topics that were suggested by students were typical topics that many students struggle with in the Linear Algebra course.

The data in this article is all the data collected in phase one. The design and implementing of dynamic mathematics videos in higher education was presented for the first time at the EMOOCs conference.

3.3 Planning of dynamic videos

As previously mentioned, dynamic branching videos have not been a widely used video format, so there is not so much information online that helps to determine the choice of the most suitable types of software/platforms, etc. This makes the planning part more time consuming, since the decision on a final platform needs to be made after proper and thorough tests with all the functions that might be needed for the videos. In total 15 possible candidates for platforms were selected and investigated. Among them five were tested thoroughly. Each of the platforms has its strengths and flaws which required adjustment from the author to adapt while making the video. Two of the candidates made the cut for making the final version of videos for students. One is Ekostudio[1], and the other one is Adventr[2]. Since both of the platforms have the necessary features needed to make the proper dynamic videos, the choice of which one will be the most used will be decided based on the students' reported experience of the platforms. A few videos were made in these two platforms to have a fair comparison.

One of the most important parts of creating dynamic branching videos is planning. That is, to have a proper clear roadmap for the video. When the video is divided into small video units, it can easily become chaotic, especially when you need to branch the videos correctly with the least possible errors. Figure 2 shows a road map of the planning of the dynamic units, with the order of the video units indicated by numbers, and arrows that show the branching relations between them. It is also important to keep the roadmap updated in case of modifying of the actual video units in the platforms.

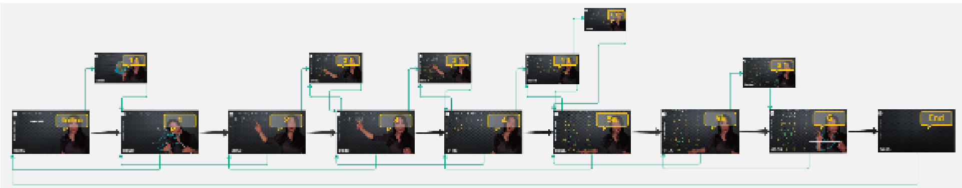

Figure 2: Roadmap for dynamic video made in Miro

The videos were divided into shorter units in Adobe Premiere Pro and uploaded to these two platforms. Figs. 3 and 4 show the interface of these two platforms. The videos were shared with the students via the author's personal webpage [9, 10].

Students can "ask" by clicking the overlay info button that appears on the screen as shown in Figure 5. As mentioned earlier, the dynamic videos can evolve after more feedback and suggestions from the students.

The topics of the videos were based on feedback from the students who are taking the Linear Algebra course in the 2023 spring semester. The one that is shown in Figure 5 is a video about conic section – that is, how to determine a conic section by eigenvalues, eigenvectors, diagonalization of symmetric matrices and orthogonal matrices.

[1] https://studio.eko.com/
[2] https://adventr.io/

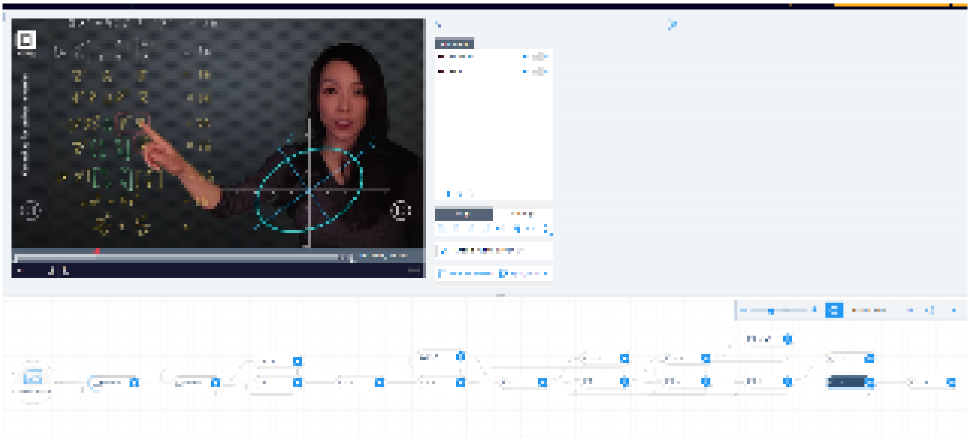

Figure 3: Screenshot from Ekostudio

Figure 4: Screenshot from Adventr

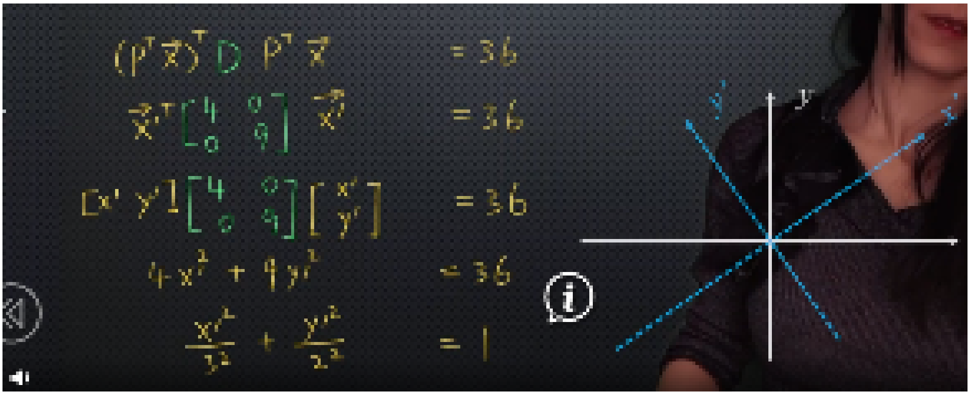

Figure 5: Info-button for branching

The length of the videos varies from less than 10 minutes to over 20 minutes, depending on how many "branches" with additional material the students choose to see.

4 Results

4.1 Student survey and interviews

According to the general feedback from the surveys and oral interviews, all the students were satisfied with the dynamic videos. By the time of writing this article, 21 students (out of the 40 who asked to join) had answered the anonymous survey, and the results are quite uniform.

On question 1, most of the participants did not have so much experience with interactive videos. Three of them had experience with the more common types of interactive videos, and they all expressed that this interactive video format fits their needs better than the other interactive videos they had seen, and they feel it is easier to concentrate.

On question 2 (whether or not their understanding of the topic of the video (conic section) had improved after they had seen the videos), 19 (of 21) responded with four or five stars (Likert scale), where five stars indicate that they completely agree.

On question 3 (how satisfied they are with the branching videos), all the participants rated four or five stars (Likert scale).

On question 4, most of the participants answered that they are satisfied with the videos as they are. One student suggested that the duration of the visibility a couple of the info buttons which indicates possibility for extra explanations could be a bit longer.

According to the feedback from the expert team, the dynamic branching videos that are described in this article make it easier for the students to focus and concentrate on the content.

We received comments through anonymous surveys, as well as follow-up comments through email from some of the students. In addition, oral interviews with the online students and on-campus students were performed. All the comments that we have received so far are positive. Some of the comments we received are given below:

"It feels like one whole video, and it feels like the teacher is giving me a real time lecture that is suited to my math knowledge".

"In my opinion, the new video reaches a new golden standard for online education."

"Me and my co-students are super impressed and satisfied with the interactive videos, and we are hoping for more videos like this in the future."

4.2 Comparison of the (interactive) videos

Two comparisons were made in the anonymous survey. One was the comparison of dynamic branching videos that are introduced in this article to other video formats students have experienced, and the other was to compare the two platforms that were used in making the videos described in this article in order to determine which one will be the more suitable for dynamic videos in the near future.

According to the survey, students in general do not have so much experience of interactive videos, so it is hard to make any clear conclusions. But most of the students have experience with regular non-interactive educational math-related videos. Compared to that category, the students have reported an improved learning experience, improved concentration when watching the videos, and increased engagement.

As for the comparison of the two platforms that were applied in this study, the students could not determine which one was better. During the oral interviews, one student mentioned that the video made with Ekostudio might have smoother transitions in interactive buttons, while the downside is that in some cases the buttons appear a bit too early.

The positive feedback from students might also be related to the main video footage that was made by using the studio "TeachUs", which has previously been received very positively by the students [11].

5 Discussion

The feedback both from students and from the three team members in this project was positive. Dynamic videos create a more seamless approach of real-time interactive lectures, and it is more suitable for student groups with varying prior knowledge in mathematics. For students who are afraid to ask questions because they feel it might be too basic for the other students will normally choose not to ask in class. But with the dynamic videos, all of the students have the possibility to get a proper follow-up in different parts of the curriculum without being concerned about taking up the time for the rest of the class.

Other factors that might also play an important role in the positive feedback might be that the video clips were filmed with the innovative studio "Teach Us" [18, 19], and the fact that the topic of the videos included in this research are topics chosen by the students, indicating that this is a topic that the students need much help with. The visibility of the lecturer and the possibility for the students to follow the lecturer's gaze and hand gestures might be a positive factor for the students' engagement. The videos offer a high degree of student interactivity and participation due to the interactive elements.

The length of the videos can also be an important factor for the engagement for the students, which was also pointed out in previous studies [5, 6]. This factor was considered in the planning phase. This might result in an increased complete-view-rate of the videos, which will be further analyzed in phase two of the project. We will also perform more detailed surveys in which we will map which factors (length, use of interactive elements, visibility of instructor etc.) the students find most beneficial in this video format compared to other educational videos they have seen.

Although there are many benefits of this new video format, one of the main challenges with dynamic videos is likely to be a high technical threshold from the teachers' side to create such videos. Most of the platforms are still in the development phase, and most of them are aiming for enterprise and commercials. Thus, it can also be challenging for creators of educational dynamic videos to find a suitable platform. In order to contribute to this area, another ongoing research which will soon be finalized will conduct a more in-depth analysis and testing of a large range of platforms that might be suitable for making branching videos like the ones presented in this article. Hopefully it will provide a useful guide for teachers who are interested in creating branching videos and who struggle to find suitable platforms.

6 Conclusion

To provide students in higher education with dynamic branching videos might lead the trend for future digital video teaching in higher education. The combination of teacher's visibility in the videos, and the seamless branching opportunity makes the videos more engaging for students. With these advantages, this innovative video format will hopefully stand out in the research of interactive videos in higher education.

To apply interactive dynamic branching videos in STEM education is still a quite new approach. Thus, their use in higher education has not yet been much researched. Another reason might be the relatively high requirement for mastering video planning and editing skills for videos in this category. The license price is generally high on dynamic branching video platforms for regular uses, which can make it less desirable for more people to try the method. Furthermore, many of the platforms that conduct this kind of video format are still in the development phase, further increasing the challenges for new users.

However, the development of technology is based on the needs of the technology. Hopefully, more published research and experiments like the ones presented in this article will contribute to increased attention to this field, and to further development of the technology, making it more accessible for future online education.

More research data is planned to be collected in the near future, both with engineering students in STEM education as well as with a large group of economics students.

Acknowledgment

I would like to thank Per Harald Ninive for the contribution in planning and testing of this video project. I would also like to thank Excited (Centre for Excellent IT Education) at NTNU for being so supportive and partially founding phase one of this video-project. Last, but not least, I would like to thank Einar Jørgen Haraldseid, Per Hansen and all the students who participated and provided valuable feedback.

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MOOC in Private Chinese Universities
Behavior and Attitude of Students Learning Foreign Languages

Wei Xue and Éric Bruillard

Université Paris Cité, EDA
F-75006 Paris, France
mariaxuewei@gmail.com | eric.bruillard@u-paris.fr

This paper investigates private university students' language learning activities in MOOC platforms and their attitude toward it. The study explores the development of MOOC use in Chinese private universities, with a focus on two modes: online et blended. We conducted empirical studies with students learning French and Japanese as a second foreign language, using questionnaires (N = 387) and interviews (N = 20) at a private university in Wuhan. Our results revealed that the majority of students used the MOOC platform more than twice a week and focused on the MOOC video, materials and assignments. However, we also found that students showed less interest in online communication (forums). Those who worked in the blended learning mode, especially Japanese learning students, had a more positive attitude toward MOOCs than other students.

1 Introduction

The MOOCs have brought heated discussions and changes in terms of teaching and learning in Chinese universities. Universities use MOOCs in two ways: online and blended. While recent studies suggested that blended learning yielded higher improvements in students' performance than solely online learning [1, 7], it cannot be denied that both modes of learning positively impacted students' achievements. In this regard, analyzing student behavior in both online and blended learning environments is crucial for better acquisition on a MOOC platform. Previous studies have explored several aspects of online and blended learning, including the usage of supported tools, instructional approaches [8], learners' achievement and academic outcomes [5]. Nevertheless, limited research has been conducted to compare student activities in online and blended learning during the COVID-19 pandemic, particularly for non-English learners of foreign languages. The suitability of different instructional designs remains a challenge in recent language MOOC studies [3], which may result in varied learning activities and attitudes toward MOOCs learning. Additionally, relevant literature has indicated the influence of cultural and learner traits [6] on students' engagement with and attitudes toward online education. Online forum participation, an indicator of learning engagement, is affected by relationship with peers and teachers, response time to questions, etc. [2].

In this study, we will examine the current usage of MOOC resources and platforms in a private Chinese university, with a particular focus on exploring potential differences between online and blended language learning. We will investigate usage patterns and acceptance levels of online learning among students studying foreign languages for the purpose of seeking an appropriate instructional design based on MOOC platform. This work is a component of a PhD study whose goal is to document collaborative activities in online learning.

2 MOOCs uses in Chinese universities

2.1 Development of MOOCs in China

The introduction of MOOCs in China has attracted a significant amount of attention in the field of education. To keep pace with the rapidly evolving landscape of online learning, universities and pioneering companies have established a number of online open course alliances, which can be broadly categorized into two types: subject-based and region-based alliances. One example of a subject-based alliance is CMFS ("China MOOCs for Foreign Studies"), which built UMOOCs platform for foreign language online courses in 2017. Similarly, the "Guangdong, Hong Kong, Macao Universities MOOCs", established in 2018, is an example of a region-based alliance. As the popularity of MOOCs continues to surge in China, the Ministry of Education has taken the initiative and supported the creation of two international MOOC platforms in 2020: iCourse and XuetangX international version. This move aims to promote the development of MOOCs and online resources, while simultaneously encouraging their internationalization. China's Ministry of Education launched the "Chinaooc" website on March 28, 2022, which consolidates all the major MOOC platforms in China and grants users' access to their data and resources, including iCourse, Zhihui Shu, ErYa, and others. In early 2023, approximately 100,000 courses are available to Chinese students through these platforms.

In this context, language MOOCs have emerged as an effective strategy due to Chinese foreign language education reform initiatives and teachers have been actively pushed to develop new courses. More than 300 language MOOCs are hosted by China's platforms (iCourse and xuetangX) [3]. A variety of MOOC have been examined with English lessons being the most frequently investigated, while the study of other minor languages occupies a small proportion in China. The research of online and blended minor languages learning is also of great significance, particularly for the influence of language type on the effectiveness of MOOC language learning [8].

2.2 Development of MOOCs in Chinese private universities

Chinese universities have actively supported the development of MOOCs in response to measures implemented by the Ministry of Education since 2013. This study examines the case of Wuhan University of Bioengineering, one of the best private universities in China. The university introduced MOOCs in September 2014, providing students with access to online learning resources. The online credits were equivalent to those of on-campus courses, which encouraged students to enroll in elective courses through MOOC platforms. Students who registered for the iCourse and completed the exam would receive a credit certificate. Up to May 2018, 150,000 students had participated in MOOCs. The emergence of MOOCs had indeed made it possible for students to get access to online learning resources, but initially, they were only used as optional courses and not as required courses. In other words, MOOCs were used as a supplementary tool for learning. However, after the outbreak of COVID-19 in 2019 and the demand for school closure in the city of Wuhan, the university employed a variety of strategies to offer remote teaching, including MOOC platforms like iCourse and Zhihui Shu, as well as videoconferencing platforms. MOOCs have served as a prominent educational resource, with MOOC platforms taking a dominant role in nearly all university courses. Even after students returned to school in September 2020, because of the uncertainty of the virus, some courses remained online while most courses were taught through blended learning, combining MOOC content with traditional classroom instruction.

This private Chinese university selected several MOOC platforms to facilitate effective online learning, among which Zhihui Shu has been used for a long time and is still in use today. Zhihui Shu, which translates to “Wisdom Tree” in English, is one of the most well-known MOOC platforms in China and offers access to 14,100 online courses, with 75 % of them exclusively designed for on-campus students and providing credits for their completion. For the purpose of using the service of this MOOC platform and its MOOC resources, the university pays a charge to the company of Zhihui Shu each semester. The university chooses and pays for multiple high-quality MOOCs on this platform that serve as credit courses. Students are able to select these credit courses through the university’s course selection system and then use the platform to begin their online studies. Two primary types of learning are provided on this platform: online learning, wherein students learn the credit courses paid for by the university, complete all online missions, and submit their credit certificates to the college; and blended learning, which combines online credit course learning on the platform with offline classroom teaching, with both the online and offline activities being evaluated.

3 Students practices and opinions about MOOCs

3.1 Data collection: Interviews and online survey

We present the findings from interviews and an online survey conducted at Wuhan University of Bioengineering. We investigated the usage and acceptance of MOOCs in an online French course, a blended French course and a blended Japanese course offered through the Zhihui Shu platform. The university provided French and Japanese classes for students interested in learning a second foreign language. 103 third-year students enrolled in the online French course from September to December 2021, during which they engaged in all learning activities using the Zhihui Shu platform. This included accessing MOOC resources principally videos, supporting materials uploaded by teachers, completing assignments, participating in group work, and other activities. 101 second-year students registered for the French blended course and 195 third-year students for the Japanese course from March to June 2022. In these courses, students utilized a blended approach that integrated on part online learning using MOOC resources in Zhihui Shu and another part of face-to-face instructions.

We started by conducting semi-directive interviews with 20 online learning students selected at random. The objective of these interviews was to gain insights into the students' collaborative experiences in online learning. In their statements, students also shared their use of Zhihui Shu for online learning, as well as their attitudes regarding this platform. All of the interviews have been recorded and transcribed and the analysis of the data is currently in progress.

To obtain a more comprehensive understanding of all students, we created an online questionnaire based on the responses provided by the interviewees. The questionnaire was designed to identify trends in online collaborative learning, including questions about students' online learning habits, such as the frequency of accessing the MOOC platform, types of learning activities engaged in, and their attitudes towards MOOC platforms. Thus far, we have received 94 answers from the online course (a response rate of 91 %) and 293 answers from the blended course (a response rate of 98 %). The in-depth analysis is still ongoing. The software Excel and SPSS are being used for this research.

3.2 Results: Learning activity and attitude of students

All students enrolled in the language courses were encouraged to make use of the MOOC platform Zhihui Shu and its resources to enhance their language learning experience. Every one of them developed his or her own pattern for organizing their online learning. Table 1 displays the frequency of MOOC platform use by students, indicating that they were actively engaged in online learning using this platform. In general, the majority of students accessed the platform several times a week. As stated in the interviews, some students preferred to watch the MOOC resource videos and review the materials once a week, while devoting another time of the week to working on their assignments. They also expressed a concern that if they did not maintain a consistent learning routine throughout the semester, they might end up with an excessive amount of work at the end of the term. However, they were less likely to utilize the platform excessively during the day due to factors such as online learning fatigue and cognitive load.

Table 1: Frequency of MOOC platform use

Learning model	2+/month & less	1/week	2+/week	1/day	2+/day
French Online (n = 94)	11 %	18 %	**49 %**	13 %	**9 %**
French Blended (n = 98)	20 %	13 %	**45 %**	19 %	**2 %**
Japanese Blended (n = 195)	8 %	21 %	**50 %**	14 %	**7 %**

Regarding the differences in frequency of platform use between online and blended learning, we observed a disparity for the French language course. The French online learners exhibited greater engagement with the MOOC platform compared to French blended students. This difference could be attributed to two possible explanations based on interview data. Firstly, online students heavily relied on the platform as their primary source of knowledge acquisition, whereas blended learning students had the option to attend offline classes, which might have been more comfortable for them, thus leading them to spend more time on it. Secondly, the assessment structure for the two types of courses differed. For the online French course, the online performance was the only factor that determined the final grade, while for the blended French course, it constituted only 50 % of the final grade, with the other 50 % attributed to the offline class performance. This assessment structure might influence blended learners to invest less time and effort in using the online platform.

In addition to monitoring usage frequency, it is crucial to consider students' online activities on the MOOC platform to track learning process and identify trends. Figure 1 presents the various learning activities that students engaged with on the platform. This finding reflects that Chinese students were focused on accessing learning materials and completing assignments, which is consistent with prior studies that reported the most frequently occurring online learning activity was accessing learning materials including slides and video lectures, shared assignments, and forum messages [4]. However, using forums was the least popular activity compared to other ones. Instead of discovering online communication, many students concentrated on the role of MOOC platforms in the domain of knowledge transfer. Interviews with students revealed that their reluctance to use forums might be due to their fear of making mistakes and losing face in public. Some students favored using the internet forum to post ideas in anonymity. Chinese students are accustomed to being cautious, and they typically view embarrassing themselves in front of others as unacceptable behavior [6]. Students with a cautious personality type may avoid speaking in online public forums. Interestingly, the French blended learners were relatively more active in the online discussions, which could be attributed to the interviewees' statement that their interactions in the offline classroom helped them become closer to one another, and led to their desire to share more in the online forum. These findings highlight the importance of considering cultural and social factors in student participation and engagement.

In contrast to blended learning students, online learning students appeared to be more reliant on the MOOC platform, as evidenced by their higher frequency of MOOC video consultations and online assignments. They were more likely to have a higher level of engagement in online learning.

After examining the learning experience on the MOOC platform, it is essential to take into consideration students' attitudes toward the MOOC platform. In line with the results of Table 2, the majority of students demonstrated a highly favorable attitude toward learning through the MOOC platform. It is observed that blended learning students tended to exhibit a more positive attitude toward the MOOC platform learning than those engaged in online learning. The online learners' neutral attitude might imply their reluctance and a lack of enthusiasm to utilize the MOOC platform. Interviewees conveyed their preference for blended learning over online learning, as it provided them with direct engagement with teachers and students, which could potentially account for this trend. They further explained that if they started learning a new foreign language that seemed challenging for a beginner, they would feel more comfortable taking a hybrid or offline lesson.

Moreover, as depicted in Table 2, students in Japanese blended learning displayed an exceptionally positive attitude toward MOOC use for learning. The university's

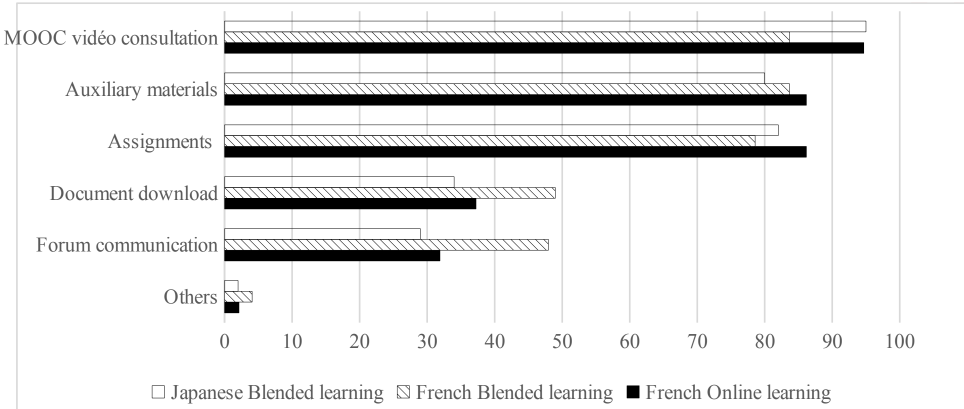

Figure 1: Online activity in MOOC platform (by percentage) (What activities do you engage in the MOOC platform?)

Japanese teacher clarified that the geographical proximity of China and Japan allowed Chinese students to easily access Japanese culture and internet-based learning resources. Such ease of access might contribute to a stronger inclination among students learning Japanese towards online language learning compared to those studying French. This emphasizes the potential influence of cultural background on individuals' attitudes toward learning.

Table 2: Attitude toward MOOC use for learning (Do you think that MOOC use and platform are beneficial for foreign language learning?)

Learning model	Strongly disagree & Disagree	Not sure	Agree	Strongly agree
French Online (n = 94)	4 %	**47 %**	34 %	15 %
French Blended (n = 98)	1 %	36 %	**46 %**	17 %
Japanese Blended (n = 195)	4 %	26 %	**40 %**	**30 %**

4 Final thoughts

Chinese authorities have made efforts for policies and recognition of MOOC certification, such as its integration with university curricula, establishment of national MOOC evaluation and accreditation system, recognition as professional qualifications. Chinese private universities are increasingly recognizing the benefits of MOOCs and are incorporating MOOC platforms and resources into their online or blended classroom setups. As part of this process, students get regular access to the MOOC platform, which exposes them to a range of tools and services. MOOC forum, as a vital tool in a foreign language class, not only offers the opportunities of social interaction and authentic collaboration, but also provides an environment to practice the target language in the context and develop pragmatics skills. However, despite the availability of online forums, students do not seem particularly engaged in these forums. In order to gain a deeper understanding of this issue and move forward, we will conduct a study based on forum observation and interviews. Specifically, the study will investigate the frequency of online forum use, the content of the forum, and how students interact with a forum. The forum constitutes an indispensable element in online collaborative activities, which is the focus of our PhD research. In addition, we observe that Japanese blended learners exhibit a high level of motivation and a more positive attitude toward MOOC learning. This discovery raises the question of whether different disciplines have an impact on students' online learning activities, which warrants further investigation.

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What makes an educational video?
Deconstructing Characteristics of Video Production Styles for MOOCs

Hendrik Steinbeck, Christoph Meinel

Hasso Plattner Institute
University of Potsdam, openHPI
hendrik.steinbeck@hpi.de

In an effort to describe and produce different formats for video instruction, the research community in technology-enhanced learning, and MOOC scholars in particular, have focused on the general style of video production: whether it is a digitally scripted "talk-and-chalk" or a "talking head" version of a learning unit. Since these production styles include various sub-elements, this paper deconstructs the inherited elements of video production in the context of educational live-streams. Using over 700 videos – both from synchronous and asynchronous modalities of large video-based platforms (YouTube and Twitch), 92 features were found in eight categories of video production. These include commonly analyzed features such as the use of green screen and a visible instructor, but also less studied features such as social media connections and changing camera perspective depending on the topic being covered. Overall, the research results enable an analysis of common video production styles and a toolbox for categorizing new formats – independent of their final (a)synchronous use in MOOCs. Keywords: video production, MOOC video styles, live-streaming

1 Introduction

"We may value a medium and prefer to learn from it simply because we like it, not because it represents an easier way to learn or because the learner perceives him or herself as more or less capable with it". Clarke & Sugrue, 1988 [1].

MOOC producers love video – and so do students. In fact, the overall popularity of video is unbroken. Rather than decreasing, we see new video formats emerging, in two extremes: Shorter and vertical-orientated and longer and community-driven live-streaming. Further advantages are cost-efficient production, a re-usable property of recorded video and an omnipresence out side of the educational usage.

Naturally and intuitively, MOOCs and videos come as a package deal. The quote above could be then seen as a discussion starter, why we even use video.

Although nobody questions the overall usefulness and effectiveness of educational video[1], a major research stream has focused on the question whether one particular format is more effective than another. Depending on the specific time-horizon, this discussion then includes the current medium-meta: be it the first arise of virtual avatars in the 2000s, the initial MOOC cohorts from 2010 or the current discussions about language models as personal tutors. In regards to video as a medium, the academic discussion has focused on specific formats (drawing versus talking) or in- or excluding a specific characteristics (e.g. speaker yes vs. no). While these research questions yield a specific insight, the actual out-in-the-wild examples of successful – in the sense of modern social media metrics – leverage a plethora of variety. If one compares the average MOOC of recorded conference video with the average YouTube, multiple differences can be seen and analyzed. Since MOOCs are usually embedded in an academic environment, conducted and taught by Professors and their PhD research team, the design and visual style guiding these teaching teams are influenced by their natural working environments. Both use video, and apart of some institutions, academic video usage is relatively one-dimensional [11]. The default video style for recorded conference talks are a Picture-in-Picture, lower angle shot of an individual in front of a computer, presenting the well-known slide-format in one take. This stands in contrast to the aforementioned YouTube formats, that would not be using this academic conference production style, but incorporate cuts, scene transitions and less slide-based knowledge presentation. Same can be said for MOOC video production. While the early days of classroom recordings are behind the MOOC community, videos seem less purposefully recorded than for social media sites. Similarly, the popularity of video channels and major MOOC platforms are equally mature and established.

In order to overcome specific styles and deconstruct their characteristics, the given paper provides a more fine-granular overview of video characteristics. Instead of reciting the *KhanAcademy style* for instance, we provide the characteristics of educational videos. Then, the discussion does not resolve around one specific style, but the characteristics of a educational video: How the channel KhanAcademy leverages a bright,*handwritten* font on a *digital blackboard*, *without* a visible *speaker* seen in order to produce videos with a typical length of *six to twelve* minutes. As we bootstrapped a total of 19 channels with three videos each from YouTube and 172 Twitch streamer the found characteristics are grounded in successful and educational video content, that allows a projection to academic and traditional video content, such as MOOC courses.

[1] E.g. see the Cognitive Theory of Multimedia Learning by Mayer 2001 [8] as one often cited source.

Against this background, the research question (RQ) is *what characteristics can be derived from of popular educational video channels*?

The RQ will be answered by a table that is the result of coding the individual channels. A second artifact of this study is a morphological table, summarizing the 92 characteristics.

The results provide producers and media teams new ideas and inspiration for academic and educational video production styles. At the same time, researchers can conduct efficiency-led study-designs, testing similar characteristics (e.g. hand-written or digital-written) in the same or different production style. As a result, MOOCs could break out of the ever-same looking video shot in front of a bookshelve or monochromatic studio green screen background, while prototyping a format that fits the specific learning goal of a video.

The given paper contributes two core aspects to the research community. First, a deconstruction of sub-elements, that *could* make an educational video. Instead of aiming for one final production style, we deliver multiple aspects, that allow fine-tuning and planning a video-based learning intervention. Second, examples of successful and specific usages of videos in major science and education-focused YouTube videos are highlighted. Therefore, the examples are grounded in a realistic context of other educators.

2 Related Work

The relevant literature can be clustered into two groups: The underlying methodological approaches and the MOOC-specific literature that frames video-based (higher) education.

Part of the first cluster are previous attempts from the research community to analyze existing (video) data sets. While YouTube itself has the "8M dataset" [14] the raw input is less suitable for a manual coding approach and filtering options are limited. Cojocea and Rebedea (2022) [2] have filtered their dataset through the keyword "school" to understand its representation across the sample. A content-specific analysis, and especially one that target higher educational content, as often seen in MOOCs, is not feasible with this approach.

The school of thought around medial analysis work by Macnamara (2005) [7] builds the grounding framework of this study. The same author suggests combining human and automated coding. Previous related works centered around the European MOOC stakeholder summit are Reutemann [11] and DaSilva et al. (2016) [3]. The first highlighted a frequency analysis of used video styles in MOOCs, underlying the repetitive visual techniques. The latter proposed a video classification grid, allowing to break down the composition of 26 MOOC teaser videos. As both publications apply their analysis to higher educational topics and deconstruct the medium video as a pedagogical and creative tool, our works extends these aspects by providing a current view with a more in-depth analysis of individual video characteristics.

Specifically on a MOOC course level, Schneider (2013) [12] conducted a similar approach, developing (sub-)categories for MOOC aspects and features of an "Integrated Learning Environment" (p. 6), characterized through Instruction, Content, Assessment and Community. In that regard, the given study lacks the assessment part, due to the public available type of content and the lack of assignments on general purpose video platforms such as YouTube.

As mentioned above, various papers focus on one distinct characteristics (e.g. speaker & social-cues y/n: [5] or handwriting: digital vs. analogue [10]). Two publications extends these discussions. The first is Lackmann et al. (2021) [6], by a study that compares two video-based condition (info graphic vs. lectures) and analyzes them on various levels of engagement, including emotional and cognitive. Usually, a lot of work is focused on learning performance alone (see the systematic review by Poquet et al. (2018) [9]). The second noteworthy work is done by Hansch et al. (2015) [4]. The work generalizes key learnings for producers, derived from existing educational videos. One of these recommendations, that motivated the given paper is "There is no one-size-fits-all approach to making a learning video" (p.13). One caveat is the overlap of video characteristics: While they underline 18 different video styles, the final (visual) product is once again treated as a priori known - something that we argue would be the result of various factors and thus an output. A novel insight is delivered by Xia et al. (2022) [13], interviewing science creators and viewers alike. They highlight different motivations (sharing knowledge about a topic, change users' behavior and education) as well as the difficulty to engage (science) enthusiasts, while also including lay people and a broader audience.

3 Methodology

The research design applies the following steps to derive the characteristics:

Identifying suitable educational channels: First, 19 established channels in the realm of science and education on YouTube.com were identified. Based on Blog articles and Top-Lists, 59 channels were considered[2]. The first quantitative requisite was at least one million subscribers, which most niche and newer channels naturally

[2]See https://www.geekwrapped.com/posts/youtube-science-rockstars-shows and https://www.reviewgeek.com/104955/the-best-youtube-channels-for-science-enthusiasts/

cannot fulfill. By focusing on larger channels, we made sure that enough content and viewers represents an established video format. In order to have a broad field of subjects, the usual representative of university faculties were preferred (STEM, jumanities, life sciences). Another qualitative requisite was set regarding the the general topic, as larger general educational and science communication channels were included as well. Content that was not specifically recorded and produced for a primarily digital audience, such as classroom and seminar recordings, were excluded. Although larger channels with educational purposes exists[3], less video production features are obtainable from this kind of material.

For each channel, the three most popular videos (used YT owns filter option) were chosen, arguing that the most often watched would represent popular and hence successful features of general science and educational content. Each of the total 57 videos were then downloaded and processed by an ffmpeg script[4] to extract an image series of snapshots from each video. As a result, a still image summary was created which was used as a start to code the characteristics. Since some of the characteristics are not obtainable from still images alone, the research team carefully watched the included material and extracted the respective aspects.

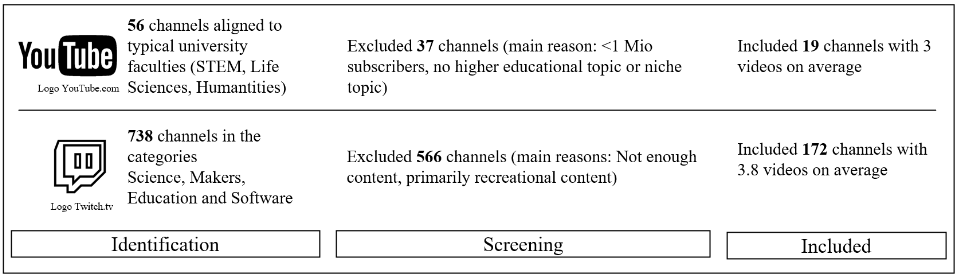

Figure 1: Data collection procedure

Table 2 summarizes the included channels and the production style they use.

Combining recorded and live-content: Finally, the existing dataset of educational live-streams have been incorporated. As part of previous work of the research group, it follows the same collection process and coding procedures. As every live-stream is a recorded video once the broadcast ends, these two formats

[3] https://www.youtube.com/@stanfordonline/ or https://www.youtube.com/@mitocw

[4] The scene-detection class with a threshold of 0.05 and 0.25 was used, which applies a sum of absolute differences to each frame.

are related and similar production styles can be derived. From a content point of view, if a live-setup is feasible and successful regarding learning gains and retention, arguably its recorded – and an even more condensed version due to post-production and cutting techniques – is sufficient as well. Even more so, as a live-stream can be cut in various smaller videos for MOOC settings or can be enriched with other video footage and narration.

Table 1: Applied procedure to code characteristics from included video data

For coding labels:	For coding categories:
1) Take new channel out of list	1) Find mutually exclusive labels
2) Open extracted image summary	2) Define difference between them
3) Extract visible characteristics (c)	3) Re- and sub-group according to
3.1) If c is unkown:	aggregation level
Insert new line in spreadsheet	
	Schedule: Two channels per session
3.2) If c is known, but new parameter (p):	to minimize carry-over errors.
Insert new parameter value	Once c is stable, assign reference point:
	Asynchronous (A)
4) Open video, apply steps 3.1 and 3.2	Synchronous (B)
	or Both (B)

At end of coding session, check for coherence and over- and undercoding of c and p.

Repeat if overlap detected, in case of doubt: Generalize c for future content.

Coding the material: As a final step, the material was viewed and the open coding procedure was followed, see Table 1.

All videos were watched with the educational purpose and higher educational learning contexts in mind. While the general call to action in *any* video might be "Like, share and subscribe", we found learning-specific call to actions. Among these are "pause the video to think for yourself" and "do the exercise we linked in the video description". For the same reason, purely recreational and gaming related activities – as these have a large subscriber and activity count – are excluded.

Comments and demographics of hosts and lecturers were excluded. The first category cannot be analyzed without further data, as the publicly visible comments are already filtered and moderated. As for the the speakers demographics, this is likely nothing a teaching team could change to produce a MOOC. Lastly, platform specific (technical) features were excluded. One example are information cards in YouTube videos, that indicate a recommended video by the currently watched creator. As we are driven by the possibilities that the medium itself provides, these features are secondary.

4 Results

Each of the channel leverages different approaches and styles, attracting millions of viewers across disciplines:

Table 2: Production style summary of the 19 included Science & Educational YouTube channels. Subs: Subscribers in Millions. Derived at March 2023.

Channel	Topic	Subs	Characteristics Summary
3Blue1Brown	Math	5.03	Scripted animation, dark background with brighter ascent colors, mascot
Bozeman Science	Biology	1.29	PiP View of visible lecturer with images or naturalistic material
CGP Grey	History & Geology	5.81	Image-based narration digital avatar, fast-paced
Chubbyemu	Medical Science	2.77	Partial display of host, stock photo and display of medical equipment
computerphile	Computer Science	2.27	Interview-driven lecture in office spaces, paper-based or IDE
CrashCourse	General Edu	14.6	Talking-head studio recording, enriched with animations and b-rolls

DIY Perks	Practical Engineering	4.15	Video summary of hands-on tutorial, various close-shots
Khan Academy	General Edu	7.78	Bright handwritten font on dark background, few anchor images,
Kurzgesagt	SciComm	20.2	Custom animations one fluid motion
numberphile	Math	4.24	Similar to computerphile; slightly more tangible items as anchor prop
PatrickJMT	Math	1.34	Top-down view of hand-written solutions to specific problem sets
Physics Girl	Physics	2.67	Documentary recordings, studio-narration, breakdown of recorded experiments
SciShow	SciComm	7.43	Talking-head, studio, green screen setting, narration with anchor images
SmarterEveryday	General Edu	10.9	Documentation style, interviews and guests, phenomenon-led narration
TheBackyardScientist	Mech. Engineering	5.57	Outdoor experiments: "what happens if?"-narrations, slow-motion perspectives

ThioJoe	Technology	2.95	Talking-head of IT problems, office environment, step-by-step PC instructions
Tyler DeWitt	Chemistry	1.33	Studio environment of two main perspectives tangible hand-written material
Veritasium	Physics, SciComm	13.5	Documentary-like videos of physics phenomena, interviews, problem-driven
Vsauce	SciComm	18.5	Informal or studio talking heads; stock-material and handwritten as well as anchor images´

The following section outlines the found characteristics and their respective categories.

4.1 Categories of Video Production

In total, seven categories with 92 characteristics that describe (a)synchronous, educational video usage have been found. Additionally, an eighth characteristics summarizes existing formats, which we labeled "the output" as the overall production style should be seen: A final result of the recording procedure and targeted learning goals. Figure 2 shows example parameters, the whole table with clickable examples can be accessed under https://www.dropbox.com/sh/e355i0773f370by/AAC5sYrbzUqzY9CDhhobXn-ra.

Audio – 5 characteristics Audio summarizes the technical container that holds information about the audio context. Among them are sampling and bit rate as well as the amount of silence or pauses a video has. This could then be used as a proxy to measure how fast-paced a learning video is.

Channel – 20 characteristics Channel describes the decisions a channel makes as a whole and what is true as an overarching characteristics. The general difficulty and main audience, including social media links and how many uploads are given are all broader information.

Chat – 12 characteristics Chat only applies for synchronous video feeds, but encapsulates the process of moderating, level of interaction, topics and usage of automated content.

Content – 28 characteristics Content is the primary aspect of how video production can be tuned and changed. Often characteristics like green screen usage, drawing style and the recording environment are included. At the same time, the used media are deconstructed through nine different parameters. Noteworthy is the information *Initial Educational Point* as most analyzed videos start with a phenomenon or layperson's questions, and not with a textbook problem. Additionally, the used material is also rather video- instead of slide-based and more than one camera perspective is used.

Content	**Main Purpose of Video**	Organizational Message	Topic Introduction	Problem set Introduction	Hands-on Problem
Content	**Initital Educational Point**	Question-led	Phenomenon result	Textbook problem	Buzzword Definition
Content	**Media**	Slides / PPT	Browser	IDE	Write (Analog)

Figure 2: Excerpt from derived characteristics for "Content"

Monetization – 2 Characteristics Depending on the MOOC platform, economic interest vary. Most of the analyzed channels pursuit economic interest. In order to outline the most common ones, two items were included (*Payment Types* and *Advertisements (embedded)*.

Output (Format) – 1 characteristics The overall video production style is as mentioned above the output of all the other decisions and input characteristics. Furthermore, one video could leverage multiple formats, e.g. starting with slow-motion footage of an experiment, followed by a narrated explanation of the underlying concepts through formulas and still images

Thumbnail – 5 characteristics Thumbnails are vital for general purpose platforms, for MOOC courses the course description and initial trailer video might be more important. As every individual encounters thumbnails and also large streaming platforms experiment with them, five found characteristics were included.

Video – 18 characteristics Similar to Audio, the video category is the technical container, describing the possibilities of a video description, frame rate, recording speed and other characteristics with 18 elements. The often discussed length of a video is included with eleven parameters, covering everything from less than three minutes to lecture-like sessions of over 100 minutes.

5 Discussion & Conclusion

Although it is intuitively understandable to compare different learning conditions against each other, measuring output variables and recommend a specific usage, the generalization of these results into other learning scenarios remain limited. For video production, there is no "golden cut", to secure learning gains or even interest in a video – recorded or live. This requires two major components: First, access to a dedicated recording and post-production process, including equipment and staff. Second, a flexible usage of these two. While it is tempting to settle for one specific style, different scenarios require different video formats. Through a general description of the 92 found characteristics, future settings can be categorized: Be it about the purchase of a lightboard, a hybrid seminar room or the incorporation of student-created material for the next MOOC. Similar to on-going questions about the ideal length of a MOOC video, the discussion then shifts to the reasons, *why* a specific production styles is more suitable for the given context. The outlined toolbox can then be used by teaching teams and course designers to match the lecturers preferences, the learning goal and the context of a MOOC unit. For research, this deconstruction of sub-elements allows to control smaller details of different conditions, while having a realistic projection of existing video-based education that our MOOC learners face on different platforms.

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MOOC-Based Personalized Learning Experience (Ple)
An Innovative Approach to Elective Courses

Paker Doğu Özdemir, Burak Can Bayer, Duygu Mercan, and Gamze Buyurucu

MEF University
Maslak Ayazağa Cd. No:4, 34396 Sarıyer/İstanbul, Turkey

This qualitative study explores the impact of Personalized Learning Experience (PLE) courses at a higher education institution from the perspective of undergraduate students. The PLE program requires students to take at least one of their elective courses in the form of MOOCs during their undergraduate studies. Drawing on interviews with six students across different faculties, the study identified four key themes that encapsulate the effects of PLE courses: (1) Certificate driven learning with a focus on occupation skill enhancement, (2) diverse course offerings to enhance personal and academic development, (3) learning flexibility, and (4) student satisfaction. The findings suggest that PLE courses offered through MOOC platforms allow students to broaden their academic horizons, gain valuable skills, and tailor their education to better align with their interests and goals. Furthermore, this study highlights the potential benefits of incorporating PLE courses in higher education institutions, emphasizing their role in promoting a more dynamic and student-centered learning environment.

1 Introduction

In today's fast-paced world, ubiquitous and continuous learning is not just an opportunity but a necessity for individuals to stay current and adapt to change. [4] discuss the MOOC pivot, highlighting the shift in focus from massive global access to more targeted, professional, and skill-based learning. This pivot presents an opportunity for MOOCs to be integrated into traditional higher education as they align more closely with the goals and objectives of formal degree programs. [5] also emphasizes the emerging "MOOC 3.0" era, in which MOOCs become more integrated into higher education, with greater acceptance of MOOCs for university course credits. This shift has led to an increased focus on the assessment and design of MOOCs, as well as their alignment with institutional standards [5].

One of the critical challenges in integrating MOOCs into higher education is the development of appropriate assessment methods to ensure that learning outcomes are met [5]. [3] examines the state of art in MOOC assessment and recognition, highlighting the need for more innovative and effective assessment methods. She discusses various assessment methods, such as quizzes, peer assessments, and e-portfolios. Furthermore, [5] emphasizes the importance of assessment in the new MOOC world, arguing that valid and reliable assessment practices are critical for successfully integrating MOOCs into higher education.

Another critical challenge is ensuring MOOCs offer a comprehensive, engaging, and effective learning experience. Since MOOCs often involve self-paced learning with limited interaction between instructors and students, concerns may arise about the quality of education and learning outcomes. The design and delivery of MOOCs are pivotal in motivating participants toward self-directed learning [6]. As [6] suggests, MOOCs ought to be structured in a manner that empowers learners to assume responsibility for their education, fosters interaction, and provides opportunities for personal growth. By integrating MOOCs into higher education, an environment that supports self-directed learning and personal development can be cultivated [5]. Furthermore, according to a study examining students' experiences with MOOCs, those who could not complete the courses attributed their failure to a lack of time due to their university workload. This issue could potentially be mitigated by motivating students to earn credits through MOOCs [1, 6].

The future of MOOCs in higher education will rely on close collaboration between MOOC providers and traditional higher education institutions to ensure the quality and recognition of MOOCs for university course credits [5]. [3] suggest that higher education institutions, MOOC providers, and accreditation bodies should collaborate to develop a more coherent and transparent system for recognizing MOOCs as a legitimate source of university course credits.

The higher education institution researched in this paper recognizes the importance of empowering students to become lifelong learners and believes that integrating MOOCs into its curriculum could provide a solution. By incorporating MOOCs, students have the opportunity to experience this mode of learning before graduation, fostering self-directed learners capable of identifying emerging trends, determining personal growth paths, and acquiring essential skills for their careers. Ultimately, this approach can cultivate proactive learners who can navigate the ever-evolving landscape of knowledge and skillsets.

To integrate MOOCs into its programs, the higher education institution in question developed the Personalized Learning Experience (PLE) program. This program requires students to take at least one elective course from MOOCs, with a minimum of 4 ECTS and not exceeding 30 ECTS. Based on the university senate's decision, PLE can be completed in place of free or restricted electives. Departments determine which course slot(s) can be taken as a PLE course, and each department appoints a MOOC coordinator. The departments determine eligible MOOCs, and courses must be at the undergraduate or graduate level and in English unless they are language courses. Passing grades only require obtaining certificates for all MOOCs taken, and the course is evaluated as "passed" or "failed." Lastly, the PLE course does not count toward the semesterly ECTS limit, as it only enters students' transcripts at the end of the semester upon the students submitting their certificates to their MOOC coordinator. Therefore, in theory, a student can complete multiple PLEs in a semester.

The university in question has a partnership with a major MOOC platform, which provides courses and seats. Students and departments determine several hundred courses they want available, with the majority of courses chosen by students through voting. Once courses are determined, students apply for seats at the beginning of the semester. Seat allocation is based on student's year of study and whether they have completed a PLE or received a seat in previous semesters. Students are added to the program along with MOOC Coordinators, who are added as program administrators and can monitor students.

Students create an appropriate learning experience for themselves based on the type of elective they will complete by bundling courses as the ECTS values of elective courses at the university typically require students to bundle three to five MOOCs. Students obtain approval from their MOOC coordinator, and this process is usually very fast and easy for free electives. If students are completing a restricted elective, the learning experience becomes slightly less personal, as the courses must align with the elective's restrictions, such as the "Humanities/Sociology Elective", "Social Sciences Elective", or "Departmental Elective". If students cannot secure a seat or choose to do so, they can complete MOOCs from platforms not provided by the university. These courses are accepted as long as the MOOC coordinator approves the courses taken and the students provide their certificates.

2 Method

This study took place at a private university in İstanbul, Turkey. Several students who completed a PLE course were contacted via email. Participants for the interviews were selected based on their availability. We interviewed one student from the Faculty of Economics and Administrative Sciences, Faculty of Art, Design and Architecture, Faculty of Engineering, and Faculty of Education and two students from the Faculty of Law, adding up to 6 students. Each student had completed a PLE at least once.

The interviews were conducted one to one over Zoom and Google Meets by the researchers. Before the interviews, the consent of the students and permission to take audio and video record of the interview were obtained. The interviews were semi-structured to leave foster deep conversation and potential serendipitous insights. In the interviews, the participants were asked broad questions about PLE's possible effect on their study habits and learning, the advantages/disadvantages of taking PLEs over regular elective courses, and whether they recommend PLEs to peers.

A basic interpretive qualitative approach was chosen for the research method. In basic interpretive qualitative research, the outcomes are descriptively presented after the data is analyzed through induction to construct different concepts and theories. This approach was considered most appropriate by the researchers as it allowed for free exploration of how students made meaning of this innovative way to complete elective courses.

The data collected from the interviews were interpreted using Thematic Analysis (TA) [2]. TA can be performed across a variety of theoretical and epistemological approaches and fit in with both realist and constructionist standards [2]. We used the TA version that [2] developed in which the researcher takes an active role in organically coding the data to generate themes. They indicate that inductive approaches are particularly useful when exploring new terrain. Our analysis was, therefore, a data-driven analysis through induction; we had no prearranged coding frame. However, here, it is critical to mention that it is impossible for researchers to completely liberate themselves from theoretical and epistemological engagements when coding. We approached the data semantically in that we focused exclusively on the surface meanings of what was said during the interviews [2]. We took a realist approach to research. A theme was not necessarily produced due to commonality in the data; the researcher's judgment was needed to determine a theme [2]. As this study looked at individual experiences from a single data set (all interviews), themes were determined according to significance at each interview, data item, and level [2].

We specifically followed the next steps from [2] in our analysis but without being able to do "Doublcheck with the interviewees" as a devastating earthquake hit Turkey when member checks were scheduled to take place: 1) Familiarizing yourself with your data, 2) Generating initial codes, 3) Searching for themes, 4) Reviewing themes, 5) Defining and naming themes, 6) Producing the report, and 7) Double-check with the interviewees [2]. Each interview was coded individually by each researcher. After each, we held meetings. All researchers in meetings made complete agreements over codes. Similarly, we generated the study themes together in complete agreement over two meetings. Our research question for the study was as follows: What is the impact of PLE on a higher education institution from the perspective of the students? We found this to be a critical question as, to the knowledge of the authors, an analysis of a higher education course model that allows credits via MOOCs has not been conducted in the literature.

This study offers insights into the impact of PLE on higher education from students' perspectives but has limitations, including small sample size, selection bias as participants were chosen based on their availability, which may have introduced selection bias, lack of member checks, and a single institution context. These factors may limit the generalizability and accuracy of the findings, and future research should address these limitations for a more comprehensive understanding.

3 Results

From the analysis of the data, four themes emerged, which are as follows:

3.1 Certificate-driven learning with a focus on occupation skill enhancement

Students reported that the program contributed significantly to their career development, motivating them to obtain certificates that are recognized and salient within their respective fields. The effective content of the courses, designed to cater to occupational development, inspired students to pursue the program to acquire practical work skills and professional growth.

Student 1: "For the psychological counseling and guidance program, communication and empathy are important, so I took courses based on that."

Students highlighted the importance of being motivated by both learning and the prospect of earning certificates, demonstrating the program's success in addressing the needs of students who seek to enhance their occupational skills and advance their careers. A Faculty of Art, Design and Architecture students said the following:

Student 4: "Different certificates from different schools are in my portfolio. This is very critical for me."

Overall, the Personalize Learning Experience program is perceived as a valuable resource for students seeking to bolster their professional development through certificate-driven learning that emphasizes the acquisition of relevant, practical skills and soft skills they would have otherwise potentially been unable to acquire.

Student 5: "It changed my day-to-day interactions with my colleagues at work; that is the level of impact it had on me."

3.2 Diverse course offerings to enhance personal and academic development.

The results reveal that students perceive the program as offering diverse course options that contribute to their personal and academic development. Students appreciate the opportunity to take MOOCs as elective courses, addressing the deficiency in elective course options within their departments.

Student 1: "As a psychological counseling and guidance counselor, there were not any elective courses that I thought would develop the skills I needed, so I turned to PLE."

The program enables students to experience unique learning opportunities and access courses from other disciplines, promoting interdisciplinary learning and personal interest development. Furthermore, the diverse course and content offerings, including courses from high-quality universities, foster various learning experiences while emphasizing the importance of elective courses for self-improvement.

Student 6: "Courses made me say: I never thought about this issue in this respect... Not only in the field of law but also in other fields, ... it gave me different perspectives ..."

The variety and richness of perspectives motivate students to engage in learning and focus on self-development, ultimately enhancing their educational experience.

3.3 Learning flexibility

Further, the results emphasize the program's adaptability to individual needs and preferences. The program's structure allows students to learn at their own pace and space, providing flexible time management options that cater to different learning preferences and schedules and easing the students' stress.

Student 6: "There is no homework you have to hand in regularly, and there aren't lessons you have to be at. It keeps the schedule more flexible, and that makes it very pleasant."

This flexibility extends to various aspects of the program, such as diverse assessment methods and the opportunity to earn credit.

Student 5: "That is because we can count them out of the course credits ... This means that if I pass all my courses ..., I can finish school almost a term early."

However, it is important to note that Student 4 indicated that the program required self-regulation as he would often forget to do the assignments of the MOOCs he took. Overall, the Personalize Learning Experience program offers significant flexibility, empowering students to create a personalized learning journey that aligns with their unique needs, interests, and schedules.

3.4 Student satisfaction

Lastly, during the interviews, students repeatedly expressed satisfaction with various aspects of the program, including the effective content and the time efficiency it offers. The development in the field of personal interest and the dual advantage of earning both credit and certificates contribute to the overall positive experience. Furthermore, students reported that the program's success has led to a snowballing of suggestions, with many participants recommending it to their peers.

Student 5: "I recommend this to all my friends."

This satisfaction extends to the enjoyable nature of the courses, which cater to personal interests and promote personal development. The inclusion of courses from high-quality universities and the program's ability to ease the stress on GPA further enhance the students' satisfaction with the program.

Student 2: "The process went very well for me because I had the opportunity to take the courses that interested me from good universities."

Student 3: "... it is another good thing that there isn't a certain grade in the transcript for it and that it does not affect your GPA."

However, Student 6 said that the pass/fail nature of the course worried her as it is believed that this is not a good look in the transcript when applying to a graduate program. In summary, however, the Personalize Learning Experience program has garnered positive feedback from students, who appreciate its effectiveness, enjoyability, and focus on personal interests and development.

4 Conclusion

The findings of this research resonate with the broader literature on integrating MOOCs into higher education, emphasizing the potential of MOOCs to contribute to the students' personal and professional growth [4, 5, 6]. The Personalized Learning Experience (PLE) program's success in enhancing students' occupational skills and promoting interdisciplinary learning is consistent with the emerging "MOOC 3.0" era discussed by [5], which emphasizes the integration of MOOCs into higher education curricula.

The PLE, in a way, overcomes the robust assessment problem of integrating MOOCs into higher education curricula, which [5] and [3] discussed, by allowing students to create their own learning experiences as the university employs MOOCs only for elective courses. In fact, the committees for the Faculty of Art, Design and Architecture, Faculty of Engineering, and Faculty of Law decided not to allow PLE for departmental elective courses (a type of restrictive elective) in their programs due to the assessment problem. This left PLE to be a free elective dominant program in which students seem to be motivated, as can be inferred from the results of this study, to complete courses without skiving. Relatedly, the PLE overcomes the challenges of ensuring MOOCs offer a comprehensive, engaging, and effective learning experience [6] by not only partnering with a quality MOOC platform that provides courses from esteemed universities but by also appointing

MOOC coordinators who can view courses and decide on their appropriateness. In fact, most MOOC coordinators pay close attention to the number and quality of summative assessments in a course among other design elements. Moreover, as multiple authors in the past indicated, the program was able to overcome self-regulation concerns by crediting MOOCs [5, 1, 6] as a part of graduate programs.

In conclusion, the PLE's success in this study highlights the potential of integrating MOOCs into higher education to empower students to become lifelong learners [4, 5]. The themes that emerged in this research emphasize the importance of MOOCs in addressing students' current diverse needs and preferences. However, close collaboration between higher education institutions, MOOC providers, and accreditation bodies is essential to ensure the quality and broader recognition of MOOCs for university course credits [3, 5].

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An asynchronous cooperative leaning design in a Small Private Online Course (SPOC)

Halvdan Haugsbakken and Marianne Hagelia

Østfold University College
B R A Veien 4, 1757 Halden, Norway
Halvdan.Haugsbakken@hiof.no | Marianne.Hagelia@hiof.no

This short paper sets out to propose a novel and interesting learning design that facilitates for cooperative learning in which students do not conduct traditional group work in an asynchronous online education setting. This learning design will be explored in a Small Private Online Course (SPOC) among teachers and school managers at a teacher education. Such an approach can be made possible by applying specific criteria commonly used to define collaborative learning. Collaboration can be defined, among other things, as a structured way of working among students that includes elements of co-laboring. The cooperative learning design involves adapting various traditional collaborative learning approaches for use in an online learning environment. A critical component of this learning design is that students work on a self-defined case project related to their professional practices. Through an iterative process, students will receive ongoing feedback and formative assessments from instructors and follow students at specific points, meaning that co-constructing of knowledge and learning takes place as the SPOC progresses. This learning design can contribute to better learning experiences and outcomes for students, and be a valuable contribution to current research discussions on learning design in Massive Open Online Courses (MOOCs).

1 Introduction

Initially, Massive Open Online Courses (MOOCs) focused on collaboration, as exemplified by cMOOCs and the work of Siemens and Downs completed at the end of the 2000s. Early MOOCs, however, did not appear to be organized in the conventional way typically associated with collaboration, as they did not require students to work in groups. Instead, they utilized the affordances of actors, ties, and resources embedded in social networks, scalability, and co-laboring to facilitate the co-construction of learning and knowledge in online education. This was achieved, in part, by incorporating learning activities where students provide feedback to each other, such as discussion threads and student peer-assessment, representing acts of co-laboring without traditional group work. Later on, incorporating such approaches in conventional xMOOCs presented challenges, as evidenced by the limited research available on collaborative approaches (e.g. [1, 18]).

Despite these challenges, research indicates that collaborative learning can enhance student outcomes, fostering self-efficacy and self-organization [2]. Online courses can utilize discussion forums and peer assessments. With this in mind, this short paper examines a novel asynchronous cooperative learning design approach to be organized in a Small Private Online Course (SPOC). This approach integrates various conventional collaborative learning activities along a longitudinal trajectory. Students are primarily tasked with completing an extensive individual case project, in which they define the topic and scope and relate it to their work practices. To develop it, the individual case project is embedded and aligned with smaller collaborative learning activities, such as discussion threads and student peer assessments. In these learning activities, students receive feedback from their peers and instructors at specific points, contributing to the development of the case project. In this way, acts of co-laboring are performed in practice.

This approach will be explained in the remaining parts of this short paper, which is structured as follows: the first section presents relevant research the short paper intends to engage with, the subsequent section explains the learning design, and the conclusion offers a brief discussion.

2 Relevant research

To outline the asynchronous cooperative learning design, a relevant research horizon must be identified in order to establish knowledge gaps and potential contributions. This short paper aims to engage with emerging research literature on MOOCs and learning design. This research area is inspired by instructional and learning design, with [5] highlighting the foundation of instructional design in behaviorist and cognitivist learning theories, while learning design is rooted in sociocultural learning and activity theories. However, MOOCs face considerable challenges, as ongoing research documents low completion rates [21], low instructional quality [19], and learners' engagement with course content and experience of limited peer engagement [17]. Such factors create contradictions in learning. First and foremost, they underexploit the potential value emerging from co-constructed knowledge through learner interaction, meaning that the social aspect of learning is underused. Addressing this issue necessitates a greater emphasis on designing collaborative learning activities in online courses, underscoring the importance of learning through social engagement, regardless of the size and scope of the online environment.

To facilitate collaborative learning, course creators can apply various available frameworks, such as constructive alignment [3] or understanding by design [22]. However, these frameworks might fall short when creating online courses, which often involve more comprehensive course design work. This suggests that learning design in MOOC making is a more complex and distinct process. For instance, learning designers need to create a coherent assemblage of interlinked learning content, learning activities, and assessment forms or activities, going beyond just a limited set of learning activities. Moreover, a MOOC is often designed for a one-size-fits-all platform, and even a predefined MOOC platform pedagogy must be considered, which presents both opportunities and constraints on the design work. That being said, it is clear that creating a MOOC is time-consuming and can constitute a transformative experience in terms of practice change from campus and classroom pedagogy to online pedagogy. This requires, among other things, the development of more comprehensive and generic MOOC approaches, which are currently in progress and being developed within the research literature [4, 9, 14, 16]. On a practical level, researchers emphasize that numerous tools for course design are easily accessible on the internet [15]. For example, simple YouTube searches provide suggestions for design approaches. These learning design approaches are inspired by pedagogical ideas from sociocultural learning theory and activity theory.

Over the years, a steady stream of conceptual papers has suggested ways to design and create MOOCs. This research offers frameworks that conceptualize MOOC creation as an ongoing, creative, and iterative process, consisting of starting with an idea and turning it into a final deliverable – the MOOC. The difference between these frameworks lies in the nuances and emphasis on the creative and iterative course design work process. In an early case study, for example, Drake, O'Hara, and Seeman (2015) [8] established five principles that can be part of a decision-making framework and guide course designers to create better MOOCs, meaning they should be meaningful, engaging, measurable, accessible, and scalable. Mor et al. (2016) [20] argue that current MOOCs need to shift from being content-centric to user-centered. To focus on the learner, course designers could adopt a cycle of inquiry for learning and develop course designs that foster the target group's growth. This means that one must identify educational challenges, review theory and practice, create and evaluate a MOOC prototype, and reflect upon the design process before launching it. On the other hand, Dona and Gregory (2019) [7] argue for a so-called participant-first approach, which views the course design process as a collaborative effort. Conole (2015) [6] has presented a widely cited framework, the 7Cs of learning design, which aims to help future course designers obtain a better overview of what an online course might look like in practice.

A limitation of existing frameworks is that they offer generic approaches to MOOC creation but provide little guidance on designing complex asynchronous collaborative learning experiences. While adopting a constructivist MOOC format [6] could be a potential solution, however, it might oversimplify the process to some degree. A primary challenge lies in conceptualizing unpredictable learning paths in collaborative design, as students in online courses adopt a wide range of strategies and trajectories [10]. MOOC learners often selectively engage with materials and activities based on their goals [13], so not all aim for course completion or full participation. Therefore, the limitations of existing frameworks call for a more tailored approach focusing on the unique aspects of asynchronous collaborative learning design. There may be good reasons for doing so. For example, research on collaborative learning activities in MOOCs, which often comes down to studies of discussion forums and student peer-assessment, indicates challenges in the performance of such designs. Studies report that discussion forums require significant instructor involvement and can easily get "lost" in the learning process due to information overload challenges [12]. In student peer-assessment, studies report that learners can be unsure of how to give feedback or seldom receive any from their peers, creating mixed learning experiences (e.g. [11, 23]). These experiences suggest that the field needs to reevaluate how to facilitate collaborative learning in online environments. In the next section of this short paper, the asynchronous cooperative learning approach will be explained.

3 The design of an asynchronous cooperative approach

To explain the core properties of the proposed asynchronous cooperative learning design, an explanation and definition are required – matters that can contribute to delimiting and clarifying the core ideas behind the learning design. Collaborative learning has its roots in educational research and is inspired by constructivist learning theories, which assume that learning occurs when learners co-construct knowledge through social interaction [2]. Collaborative learning also has other core properties; for example, it assumes that learning happens when students work together in groups to create a shared understanding, find solutions, give meaning, and develop a joint product. Furthermore, collaborative learning includes an element of co-laboring, where students contribute to some kind of end product. That being said, it is also common to distinguish between *cooperative* and *collaborative* learning. In simple terms, cooperative learning is a more teacher-controlled approach to monitoring the collaborative process, while collaborative learning gives students more autonomy [2].

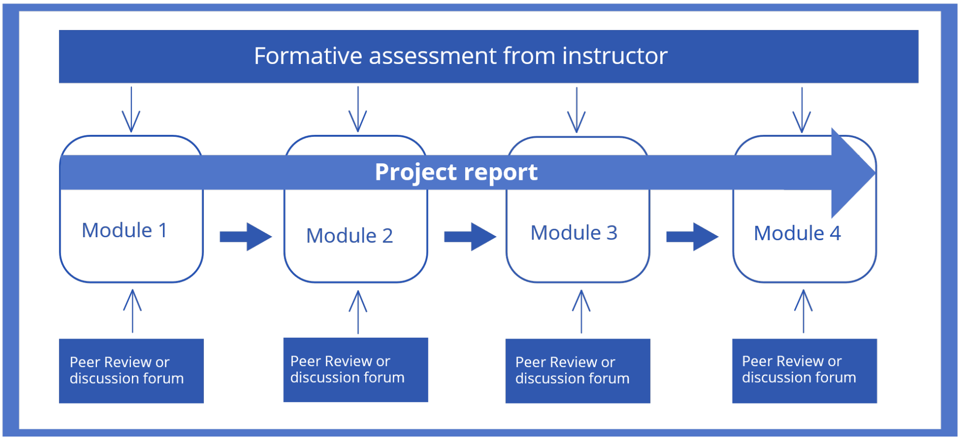

Figure 1: Visualization of cooperative learning design.

With that said, the proposed learning design adopts a cooperative learning approach, placing more emphasis on teacher-controlled learning. This property stems from the design's teacher-centered focus when examined more closely. Nevertheless, the cooperative learning design aims to create a more uniform and extensive learning structure that interconnects and combines a series of conventional learning activities commonly used in collaborative learning. The learning design prioritizes collaboration through co-laboring rather than solely focusing on group work. The learning design has certain core pillars and is displayed in Figure 1. First, the learning design is set up and conducted in an asynchronous virtual learning environment, which contrasts with the synchronous and face-to-face nature of traditional collaborative learning. Second, students work on individual case projects over a longitudinal trajectory, with topics and scope defined by the students themselves. An instructor grades the case projects, and students receive regular formative feedback from course instructors during their development. Third, a series of smaller, interlinked collaborative learning activities commonly used in online courses, such as discussion forums and student peer assessments, are embedded into the overall learning design. In these activities, students engage with specific assignments designed to develop and enhance their individual case projects. Such assignments may include providing peer feedback on particular topics and aspects of their case projects or participating in discussion threads that explore relevant topics students can apply in their projects' development. In this way, students receive and engage in a dual feedback loop: one from the course instructor and a second one where they engage with each other's case projects. This approach can be seen as creating a more interconnected and coherent asynchronous cooperative learning design. Most crucially, it attempts to utilize the value of learning that emerges from learners' social interactions, rather than engagement with prearranged learning content.

The asynchronous cooperative learning design has not yet been tested, but it is part of a concept design emerging from a research and development project. This project aims to develop an online course that introduces teachers or school managers, who are the target group for the SPOC, to perspectives on digitalization and organizational theory. A course syllabus, complete with learning objectives and assessment methods, is currently under development as this short paper is being written. In addition to engaging with learning content, activities, and assessment tasks organized in an xMOOC educational model based on a modular setup, a primary goal is for students to develop analytical skills. These skills are considered crucial for teachers aspiring to assume leadership roles within schools. This skillset revolves around the ability to apply different perspectives from organizational theory and research to the aforementioned case project assignment. In the case assignment, students select a relevant case, ideally from their own workplace, and define a topic, formulate research questions, collect data, and synthesize an analysis that offers a point of view on the extent of the school's digital integration. Through this process, with robust support from instructors and fellow students in the form of feedback and engagement in smaller collaborative learning activities, students conduct a meta-analysis. This identifies areas requiring intervention to facilitate digital transformation and effective leadership.

By applying the proposed asynchronous cooperative learning design within a SPOC, it can be argued that the conventional project task format is somewhat redefined and readopted to suit collaborative learning purposes in an online setting. As commonly known, project assignments offer students the opportunity to delve into practice-related topics or issues and demonstrate their comprehension and abilities within a specific domain. These assignments can vary in scope and complexity, ranging from smaller projects requiring a few weeks to larger ones lasting several months, usually organized as part of campus pedagogy. Typically, a project assignment entails defining a topic, performing an investigation or exploration, and presenting the findings and conclusions. Project tasks often emphasize practicality, enabling students to explore subjects in a more applied manner compared to conventional academic assignments like essays or exams. Furthermore, they can offer experience in collaboration, as many projects necessitate teamwork and creative solutions to emerging challenges. In higher education, project assignments are generally assessed based on several criteria, including the quality of research and analysis, relevance to the subject matter, originality, presentation and organization, and creativity. In the proposed cooperative learning design within a SPOC, however, these affordances can be developed. However, the next round of testing will determine how beneficial the design can be.

With that in mind, it is essential to provide a general overview of the SPOC's course organization. The SPOC uses a modular setup, consisting of four modules, and follows an asynchronous education format, as mentioned. In the first module, students are introduced to topics related to digitalization in schools and society. They must prepare the problem statement and objectives for their project assignment, providing a description of the project's focus and purpose. To achieve this goal, students must conduct a preliminary analysis of their own school, generate results, and reflect on these findings. In Module 2, students engage with administrative documents and theoretical models in the context of digitalization. They receive a brief introduction to the methodology and, based on their prior analysis, interview staff members and reflect on their own school's situation. Module 3 involves students working with organizational theory. They review relevant theories, research, and practices that may pertain to their project. In Module 4, students focus on results and conclusions, presenting their project findings and discussing the implications of these findings for their own practice.

4 Discussion and conclusion

As mentioned, the learning design proposed in this short paper is under development and has not yet been tested on students. Nevertheless, it provides a basis for discussing the potential benefits of fostering collaboration among participants in MOOCs. In this context, cooperation can emerge as a feasible and effective approach to enhance learning experiences and outcomes. Sharing ideas and gaining new insights are not exclusive to collaboration; they can also be fostered through structured and teacher-guided cooperation. Cooperation enables participants to work together on shared goals while maintaining their independence and autonomy, ensuring that even in a short online course, students can engage with each other and contribute to the overall learning experience. Cooperation is well-suited for the short-term and loosely networked nature of MOOCs and can be a crucial component. It allows participants to collaborate and share ideas while respecting each other's autonomy.

In the proposed MOOC design, familiar elements used in collaborative learning are incorporated in a novel and interesting way. What makes the design interesting is not the individual elements, but the manner in which they are assembled and integrated as part of a larger design. Within the framework of the SPOC, the well-known project assignment spanning across all modules is included, with students gradually building it up. The project assignment is a practical task based on the students' own workplace, making it more meaningful and motivating for them to continue working on it. They can use the project outcomes after completing their studies. Also, instead of traditional group work, asynchronous student peer-review and discussion forums are included and designed as part of the module setup, thereby interlinking cooperation as part of larger online learning experiences. This approach aligns with the cooperative nature of MOOCs, facilitating the exchange of ideas and insights without requiring synchronous group work. By engaging in cooperative activities, online students can benefit from the diverse perspectives and knowledge of their peers, leading to a richer learning experience. Students can exchange ideas and insights by using the learning platform to visualize and spread ideas to a larger community, inspiring them to think differently and approach problems from various angles. Cooperation also facilitates engagement, as learners can participate in discussions and contribute with their expertise.

By promoting cooperation in online courses, educators can ensure that learners benefit from the expertise and perspectives of their peers, leading to a richer and more engaging educational experience. In this context, cooperation is an effective strategy for enhancing learning outcomes and the sustainability of online courses.

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Role of MOOCs and Imoox for Austrian Universities
Analysis of Performance Agreements and Activities at imoox

Martin Ebner[1], Sarah Edelsbrunner[1], Katharina Hohla-Sejkora[1], Silvia Lipp[2], and Sandra Schön[1]

[1] Graz University of Technology, Graz
[2] University of Graz, Graz
martin.ebner@tugraz.at

This research paper provides an overview of the current state of MOOCs (massive open online courses) and universities in Austria, focusing on the national MOOC platform *iMooX.at*. The study begins by presenting the results of an analysis of the performance agreements of 22 Austrian public universities for the period 2022–2024, with a specific focus on the mention of MOOC activities and *iMooX*. The authors find that 12 of 22 (55 %) Austrian public universities use at least one of these terms, indicating a growing interest in MOOCs and online learning. Additionally, the authors analyze internal documentation data to share insights into how many universities in Austria have produced and/or used a MOOC on the *iMooX* platform since its launch in 2014. These findings provide a valuable measure of the current usage and monitoring of MOOCs and *iMooX* among Austrian higher education institutions. Overall, this research contributes to a better understanding of the current state of MOOCs and their integration within Austrian higher education.

1 Introduction

Universities have traditionally reserved their educational offerings for a select group of students, typically those with university entrance qualifications. However, MOOCs provide a unique opportunity for these institutions to broaden their reach and offer educational resources to a wider audience. The benefits of MOOCs extend beyond increased accessibility, as they allow for a diverse range of perspectives to be combined in a single course and offer flexible access to course content. MOOCs are especially useful for creating continuing education programs that can reach individuals unable to attend face-to-face events due to time and mobility constraints [16].

The Austrian platform *iMooX.at* is a central platform for MOOCs, and many Austrian universities act as providers of these courses, with hundreds or even thousands of participants enrolled in each. However, there is a lack of data and information regarding the current state of MOOC dissemination in Austrian higher education. This paper seeks to address this gap by analyzing the performance agreements of Austrian public universities for the period 2022–2024, focusing on the mention of MOOC activities and the *iMooX* platform. By examining these documents, the authors aim to provide a more detailed description of the status of MOOC dissemination in Austria and identify potential avenues for future growth and development.

2 Usage of MOOCs at Austrian universities

With the outbreak of the Covid-19 pandemic, the associated closures of universities, and the transition to phases of only distance learning, the experiences and practices of students and teachers have changed significantly [15]. However, while little is known about the actual use of MOOCs by students in Austria, numerous publications regarding the establishment and implementation of MOOCs at Austrian universities can be referred to. In the following, we briefly describe MOOC developments available in the current scientific literature.

After the launch of the *iMooX.at* platform in 2013, one article, initially still cautiously, posed the question: "Introducing MOOCs to Austrian universities – is it worth accepting the challenge?" [14]. In the following years, several contributions dealt with the use of individual MOOCs on *iMooX.at*, for example in the field of engineering [4], the STEM MOOCs by the TU Austria [12], the use in a university cooperation for teacher education [7] or the promotion of digital competencies among employees [10]. Some contributions from Austria also look at MOOCs from other MOOC platforms [11]. Another group of contributions deals with novel teaching scenarios using MOOCs [7], new teaching design principles involving MOOCs such as "Inverse Blended Learning" [3], but also the role of open educational resources for various use cases in online courses ([5] or recommendations for MOOCs in the field of adult education [16]. Several contributions to MOOCs also exist in the context of learner data analysis, in other words learning analytics (e.g. [13]). Evidence on student use of MOOCs and the role MOOCs play for higher education institutions is still scarce. This paper attempts to provide the impetus to fill this research gap.

3 Methodology

For this article, two approaches have been chosen:

(a) The performance agreements of the 22 Austrian public universities have already been analyzed in [9, 8] for a possible mention of the term OER and related terms. In this paper, the current performance agreements (for the period 2022–2024) were analyzed regarding the mention of "MOOC" or "iMooX" [6]. Performance agreements are publicly available in Austria and are a sort of contract between a public university and the ministry for two years, defining and declaring future steps beyond their regular duties. These documents are about 80 to 100 pages long. The simple, text-based analysis consisted of searching for the terms MOOC and *iMooX*. Simple statistical analysis will be applied for the result presentation. These results are presented in English for the first time. The corresponding texts are a translation of the article already published in German [6].

(b) Then, it was analyzed how many of the different types of higher education institutions in Austria have already offered a MOOC on the platform *iMooX.at*. For this purpose, we use internal documentation as the platform operator of *iMooX.at*; these results will be shared publicly for the first time. Official data regarding the university landscape, provided by public sources such as the ministry, are used as a basis. Again, our analysis consists of simple descriptive statistics.

4 Evaluation Results

The results of the two analyses are presented below.

4.1 Spread of MOOC and iMooX in performance agreements

The performance agreements concluded between the Austrian public universities and the Federal Ministry of Education, Science and Research from 2022 to 2024 were examined about the mention of the term MOOCs or *iMooX*. An overview of the results of the quantitative content analysis can be found in Table 1.

Twelve of twenty-two universities (55 %) mention the terms MOOC and/or *iMooX.at* in their performance agreement or have already named specific goals in this regard. Of these, six universities cite the intent to produce or (further) develop MOOCs and/or *iMooX.at* (Academy of Fine Arts Vienna, Medical University Graz, University of Leoben, Paris Lodron, University Salzburg, Graz University of Technology, Vienna University of Technology). Two universities, the University of Natural Resources and Applied Life Sciences Vienna and the University of Continuing Education Krems, cited the development of OER and their provision and use of MOOCs and/or *iMooX.at*. Another two universities award their intention to jointly develop, offer and implement courses in a university partnership using *iMooX.at* (University of Applied Arts Vienna, Vienna University of Economics and Business).

Table 1: Mentions of the terms MOOC and *iMooX* in the performance agreements of the 22 public universities in Austria from 2022 to 2024.
Source: Analysis of results presented in [6].

Mentions of terms	Number of universities with mentions (percent)	Number of universities without mentions (percent)
Mention of "MOOC"	9 (41 %)	13 (59 %)
Mention of "iMooX"	7 (32 %)	15 (68 %)
Mention of "MOOC" and "iMooX"	4 (18 %)	18 (82 %)
Mention of "MOOC" or "iMooX"	12 (55 %)	10 (45 %)

The Vienna University of Technology also states in its performance agreement that MOOCs will be used to create an additional digital information channel for prospective students. In addition, the university promotes support for teachers in the development and subsequent use of open educational resources such as *iMooX.at*. Two universities see university cooperation on *iMooX.at* and support for these platforms as a contribution to achieving social objectives (Graz University of Technology, University of Continuing Education Krems). The performance agreement of TU Graz also states that it plans to establish an *iMooX.at* partnership board consisting of five universities by 2024, as well as calls for Excellence MOOCs and MOOC kick-offs.

Figure 1 visualizes the results in a pie chart. It must be noted that the number of students greatly varies between public universities (Bundesministerium für Bildung, Wissenschaft und Forschung, 2022 [1]). In fact, the percentage of students studying at a university where MOOC or *iMooX* is mentioned is much higher, especially since large universities like the University of Vienna mention the topic in their performance agreements.

4.2 Development of MOOCs per university: Analysis of the *iMooX* documentation data

The *iMooX* platform has been documenting all MOOCs and organizers on *iMooX.at* since its inception. To better understand the extent to which Austrian universities have become involved with the platform, we have compiled a list of universities that have provided a MOOC. Table 1 below provides an overview of the current state as of March 2023.

To contextualize the results, it is essential to consider that the majority of students in Austria attend public universities, comprising about 70,000 individuals, while

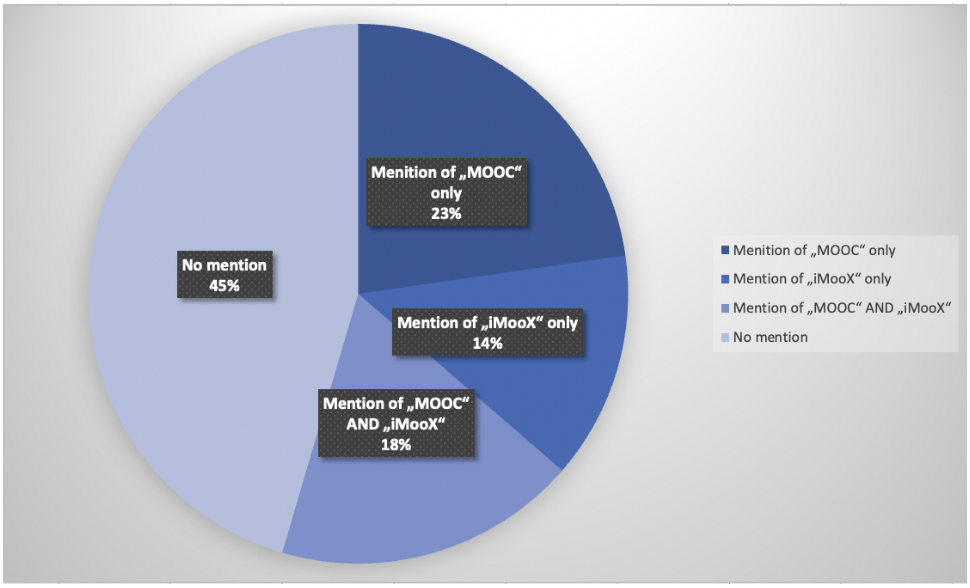

Figure 1: Percentage of 22 public universities mentioning MOOCs and/or *iMooX* in current performance agreements (2022–2024).

only a small proportion of students attend private universities, which amounts to approximately 2,700 students as reported by the Bundesministerium für Bildung, Wissenschaft & Forschung [1].

5 Discussion

About half of all public universities have registered and already organized a MOOC on *iMooX.at*. A third of all universities of applied sciences and a quarter of university colleges of teacher education did so as well. The slight discrepancy between the number of mentions of MOOCs in performance agreements and the number of universities that have produced a MOOC thus far, aligns with our own experience. We have been in communication with two other universities that are currently planning to develop a MOOC at *iMooX*.

Two major limitations should be noted in the analysis presented: For the analysis of the performance agreements, it must be added that only some university activities need to be mentioned there. Therefore, it is possible that universities may want to implement MOOCs or MOOC-related activities but have not described them

Table 2: Number of Austrian universities by university type that have already offered at least one MOOC on *iMooX*.at since 2014.
Source for the number of universities in Austria in 2023: Bundesministerium für Bildung, Wissenschaft und Forschung [2]

Type of the University	Number of universities (03/2023)	Number of universities that have already offered at least one MOOC on iMooX (in percent)
Universities (public)	22	11 (50 %)
Universities of Applied Sciences (public)	21	7 (33 %)
University Colleges of Teacher Education (public)	14	4 (27 %)
Private universities and Universities of Applied Sciences	18	0 (0 %)

in their performance agreements. This is specifically the case for project-related MOOC developments the authors of the performance agreements were not (yet) aware of. For the second analysis, it needs to be added that Austrian universities might not or not only use *iMooX.at* as a platform for their MOOCs. Especially if universities are part of European projects, they might also use other platforms not analyzed in this publication. To capture these activities, a survey of all universities would need to be conducted in the future.

A major advantage of the data presented is to be able to determine future developments and, if necessary, quantify them better. In a next step, we would like to provide more targeted support for re-using MOOCs by third parties – especially such universities that have not already developed their own MOOCs at *iMooX* – and try to quantify it.

Acknowledgment

This article was partly written with the help of funds from the project "iMooX – The MOOC platform as a service for all Austrian universities" (2020–2023, partners: TU Graz, University of Vienna), funded by the BMBWF. Thanks to the (then) students at the University of Graz, Iris Steinkellner and Ivana Stojcevic, who made the original analysis of the service agreements [6].

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Promoting Global Higher Education Cooperation
Taking Global MOOC and Online Education Alliance as an Example

Wang Xiaoxiao and Guo Shuangshuang

Global MOOC and Online Education Alliance
Floor 9, Kejian Building, Tsinghua Science and Technology Park,
Haidian District, Beijing, China

The massive growth of MOOCs in 2011 laid the groundwork for the achievement of SDG 4. With the various benefits of MOOCs, there is also anticipation that online education should focus on more interactivity and global collaboration. In this context, the Global MOOC and Online Education Alliance (GMA) established a diverse group of 17 world-leading universities and three online education platforms from across 14 countries on all six continents in 2020. Through nearly three years of exploration, GMA has gained experience and achieved progress in fostering global cooperation in higher education. First, in joint teaching, GMA has promoted in-depth cooperation between members inside and outside the alliance. Examples include promoting the exchange of high-quality MOOCs, encouraging the creation of Global Hybrid Classroom, and launching Global Hybrid Classroom Certificate Programs. Second, in capacity building and knowledge sharing, GMA has launched Online Education Dialogues and the Global MOOC and Online Education Conference, inviting global experts to share best practices and attracting more than 10 million viewers around the world. Moreover, GMA is collaborating with international organizations to support teachers' professional growth, create an online learning community, and serve as a resource for further development. Third, in public advocacy, GMA has launched the SDG Hackathon and Global Massive Open Online Challenge (GMOOC) and attracted global learners to acquire knowledge and incubate their innovative ideas within a cross-cultural community to solve real-world problems that all humans face and jointly create a better future. Based on past experiences and challenges, GMA will explore more diverse cooperation models with more partners utilizing advanced technology, provide more support for digital transformation in higher education, and further promote global cooperation towards building a human community with a shared future.

1 Introduction

Since 2011, MOOCs have developed on a global scale [2], opening a new chapter in online education. Because MOOCs can enable learners from all over the world to receive high-quality education without leaving home at a lower cost, it is conducive to the realization of SDG 4 which is to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" [4]. Despite the many benefits of MOOCs, people also have higher expectations for online education. For example, it is expected that there will be more sufficient interaction in the online learning process [3], more opportunities to summarize and exchange the experience of large-scale online education around the world since the outbreak of COVID-19 [1], and more opportunities to work with learners from diverse backgrounds to solve problems through cooperative learning [6]. Therefore, in the field of online education, how to strengthen interaction and promote global cooperation is an important issue that needs to be solved.

In response to global educational challenges and opportunities presented by the age of the internet and virtual interconnectivity, world-leading universities and platforms play an extremely important role. The Global MOOC and Online Education Alliance (GMA) was founded in 2020, with the mission of building a diverse community of world-leading universities and platforms, fostering international cooperation on educational technology and innovation, and leading by example and contributing towards the achievement of SDG 4.The GMA was initiated by 17 leading universities and three online education platforms from 14 countries across six continents[1], with its Secretariat located at Tsinghua University, Beijing, China. As a mechanism for exchange and cooperation, the GMA provides leadership in global higher education to address online education challenges and implements practical policies in members' respective communities and around the world. To achieve its mission, the GMA mainly focuses on four aspects of work, namely joint teaching, capacity building, knowledge sharing, and public advocacy. Through nearly three years of exploration, the GMA has accumulated certain experience in promoting global higher education cooperation and yielded fruitful results.

[1]The GMA Founding Members are Cornell University, *edX*, LPI (Learning Planet Institute), Mongolian University of Science and Technology, Nanyang Technological University, Peking University, Politecnico di Milano, Rice University, RWTH Aachen University, Saint Petersburg University, Shanghai Jiao Tong University, *Thai MOOC*, Tsinghua University, University of Auckland, University of Chile, University of Manchester, University of Nairobi, University of Toronto, *XuetangX*, and Zhejiang University. (*Italics* are online education platforms)

2 Endeavors of Global MOOC and Online Education Alliance

The GMA's practice in promoting global higher education cooperation can be summarized as follows.

2.1 Seek Innovation in Joint Teaching and Share Quality Educational Resources

In terms of joint teaching, the GMA vigorously promotes deep cooperation among its members, as well as between members and non-members. This includes exchanging quality MOOC resources, establishing the real-time synchronous "Global Hybrid Classroom", launching systematic "Global Hybrid Classroom Certificate Programs", and other cooperative efforts.

The GMA has advanced the exchange of quality MOOC resources to enhance education quality and equity. From 2022 to the present, at the invitation of the Indonesia Cyber Education Institute, facilitated by the Secretariat of the GMA, XuetangX, along with 36 Chinese universities, has signed an agreement with the Indonesia Cyber Education Institute to provide 108 high-quality MOOCs in English or with English subtitles as a donation for Indonesian university students to study online and receive credits. Wang Libing, Chief of Section for Educational Innovation and Skills Development of UNESCO Asia-Pacific Regional Bureau for Education, and Wesley Teter, Senior Consultant of Section for Educational Innovation and Skills Development of UNESCO Asia-Pacific Regional Bureau for Education, praised the donation as "a significant achievement in promoting the international flow of quality content and pedagogy, which can help to improve the access, quality, and equity of higher education provision in the Asia-Pacific region" [9].

The GMA has established the Global Hybrid Classroom to enhance students' learning and international understanding. Global Hybrid Classroom means that when a university or college holds a class, students from other universities or colleges around the world are invited to join synchronously through online means so they can learn together and interact with teachers and students in the classroom in real time. The course transcript is available to students once they have finished their course work. From 2021 to the present, with the assistance of the GMA Secretariat, universities from different countries and regions have cooperated to offer more than 300 Global Hybrid Classroom courses. More than 2,500 students from universities such as Politecnico di Milano, Nanyang Technological University, and the University of Chile have participated in these classes synchronously online. Through online and offline hybrid learning, university students worldwide are able to attend the same class, which not only helps the students acquire knowledge and skills, but also enhances international communication and understanding.

The GMA has also launched Global Hybrid Classroom Certificate Programs to promote systemic online learning. Building on the Global Hybrid Classroom initiative, the GMA has launched ten certificate programs covering finance, applied economics, logic, environmental governance, electrical engineering, artificial intelligence and big data, social science, artificial intelligence IoT (Internet of Things), engineering management, and other fields. Students can acquire the program's certificate by successfully completing three to four hybrid courses in the program.

2.2 Promote Openness and Cooperation in Education: Strengthen Capacity Building and Knowledge Sharing

In terms of capacity building and knowledge sharing, the GMA promotes openness and cooperation in the field of education through global education communication and recognition of quality courses to facilitate experience sharing, setting examples, and providing training.

The GMA has conducted global education communication to facilitate experience sharing. Since its founding, the GMA has organized nearly 20 Online Education Dialogues. For three consecutive years, it has jointly organized the Global MOOC and Online Education Conference with the UNESCO Institute for Information Technologies in Education, inviting over 100 online education experts and scholars from nearly 30 countries worldwide and attracting over 10 million viewers globally. Through global education communication, guests shared their concepts and experiences about online education development, demonstrated excellent cases from different countries and regions, and laid the foundation for further cooperation. Stefania Giannini, Assistant Director-General for Education at UNESCO, stated at the 2022 Global MOOC and Online Education Conference: "The lifelong approach has become essential to cope with the digital transition that actually accelerated the high speed affecting every aspect of our lives. While it harbors immense opportunities, this transition is also disruptive and carries the risk of widening inequalities. That is why the focus of this conference on inclusion, equity and quality in higher education in the digital era is highly relevant." Andreas Schleicher, Director for Education and Skills, and Special Advisor on Education Policy to the Secretary-General at the Organization for Economic Co-operation and Development (OECD), also stated that if we could harness various kinds of opportunities, technology could create the future for us, and we see a lot of really good examples at the Global MOOC and Online Education Conference.

The GMA launched the GMA Awards in 2023 to acknowledge quality courses and establish models in the field. The GMA Awards 2023 aim to showcase examples of STEM (Science, Technology, Engineering, and Mathematics) courses that are enhanced by technology, to help individuals improve their STEM literacy [7] and to provide references for GMA members on STEM-related development. In addition, the GMA will cooperate with more international organizations apart from its members to widely publicize excellent practices, improve teachers' digital literacy, support their professional development, and help build a community of online learning.

2.3 Enhance Public Advocacy to Build a Better Future

As for public advocacy, the GMA has hosted various events such as the SDG Hackathon and the Global Massive Open Online Challenge (GMOOC) to attract learners from around the world, create cross-cultural learning communities, boost creativity, promote the resolution of global issues, and jointly create a better future.

The GMA has conducted activities around sustainable development to promote the resolution of global issues. In October 2021, based on SDG 4, the GMA launched the 2021 GMOOC with two tracks, "Education Equity" and "Lifelong Learning". The GMA integrated and built relevant online learning resources, invited global students to carry out learning and cooperative practices, and enhanced young people's understanding of inclusive and equitable quality education. 6,725 learners from around the world joined the online course learning and cooperative practices, and in the end, 12 teams composed of 47 students participated in the SDG Challenge finals. In July 2022, the GMA launched the SDG Hackathon with the theme "Digital Transformation for a More Inclusive University Campus and Learning Environment", and invited experts and scholars from UNESCO, the European Universities of Technology Alliance (EHANCE), the United States, the United Kingdom, Italy, Norway, Chile, and Mongolia to serve as mentors. In the seven-day event, more than 30 learners from different countries formed interdisciplinary innovation teams, conducted discussions and developed solutions for the integration of digital technology and higher education through online means.

Furthermore, GMA also employs education and online technology as leverage to reach wider issues such as the pursuit of human well-being and the promotion of a better shared future for the globe. In 2023, with the support of the GMA, the Tsinghua University School of Social Sciences cooperated with the Applied Positive Psychology Program of the University of Pennsylvania to launch a GMOOC on "Positive Psychology". The course was open to 100 learners worldwide, encouraged to form teams and conduct cross-cultural exchanges and collaborations through online learning and mentor guidance. The learners used creative thinking to incubate innovative ideas and solutions to challenging problems, and through this process, they acquired knowledge and skills in positive psychology to help them achieve a better future. As we believe, online is not only a method for teaching and learning, but also a crucial approach for cooperation, especially global cooperation.

Learning from past work, the GMA has formed a three-level approach in promoting international cooperation: "Core – Field– Beyond" (See Table 1). By utilizing information technology to break spatial and time limitations, the GMA gathers wisdom and strength from both inside and outside, from different countries and regions, from higher education and other industries to promote comprehensive and multi-level international cooperation and development in MOOCs and online education. This effort helps to build a human community with a shared future and promote sustainable development (See Figure 1).

Table 1: Summary of Endeavors of GMA

	Joint Teaching	Capacity Building and Knowledge Sharing	Public Advocacy
Level	Core of Higher Education	Field of Higher Education	Beyond Higher Education
Feature	The focus is on classroom and course development in higher education, with a learner-centered approach that promotes the effectiveness, efficiency of learning and learning experience.	Gathering experts and scholars in higher education to promote overall improvement in the quality of higher education through sharing experiences, setting examples, and conducting training.	The cooperation covers a wider range of global public and extends beyond the field of higher education, with the aim of promoting sustainable development for mankind.
Details	MOOC exchange, Global Hybrid Classroom, Global Hybrid Classroom Certificate Programs, etc.	Online Education Dialogue, Global MOOC and Online Education Conference, GMA Awards, etc.	SDG Hackathon, the Global Massive Open Online Challenge (GMOOC), etc.

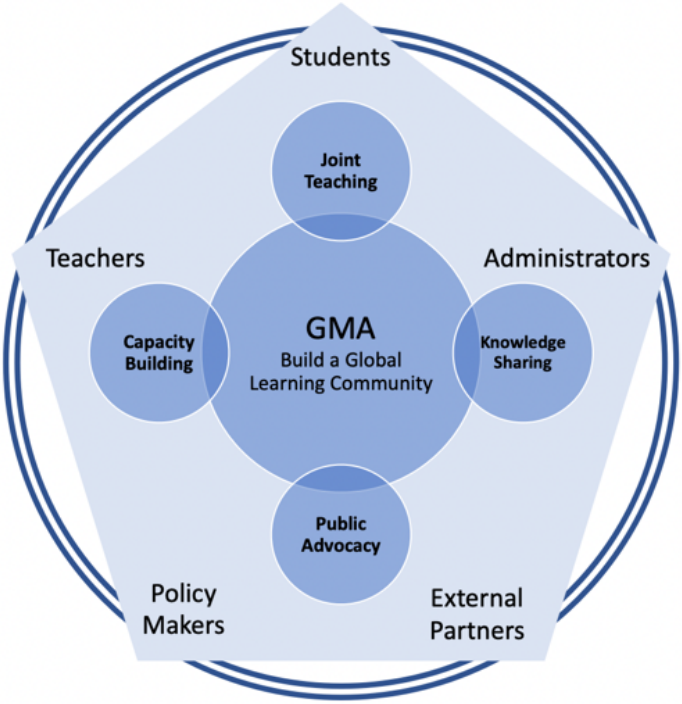

Figure 1: Global Cooperation of GMA

3 Future of Global MOOC and Online Education Alliance

Based on the GMA's practical experience in promoting global cooperation, there are several areas that could be further explored in the future, including:

First, in terms of joint teaching, the GMA will explore more diverse cooperation models with more partners utilizing advanced technology. In the future, the GMA will work closely with more like-minded partners, leveraging MOOCs, blended learning, hybrid learning, metaverse (VR/AR), artificial intelligence, and other updated technology forms to conduct diverse and collaborative teaching practices. The goal is to co-create and share global high-quality educational technologies and resources, focus on learner-centered education, improve the effectiveness and efficiency of learning and learning experience.

Second, in terms of capacity building and knowledge sharing, the GMA will provide more support for digital transformation in higher education. The GMA will further promote openness and cooperation in the field of higher education, including but not limited to: utilizing information technology to localize high-quality external resources to create a more inclusive and equitable education; promoting the formation and improvement of institutional mechanisms that match new forms of education, such as exploring credit recognition, evaluating online learning effectiveness, improving digital literacy and incentive systems for teachers; exploring the use of information technology to promote research and management work to provide stronger support for comprehensive digital transformation in higher education.

Third, in terms of public advocacy, the GMA will further promote global cooperation through online means towards building a human community with a shared future. The GMA will promote the access to high-quality educational resources for learners from different countries and regions, as well as different industries, through a broader, longer-term, and more diverse range of activities. This will be achieved through online learning and collaboration, cross-cultural communication, and the formation of lifelong learning awareness and abilities. The GMA will help enhance learners' critical thinking, innovative thinking, and international vision, optimize problem-solving abilities and global competency, and build an online learning community, constantly promoting the building of a learning society and pursuing a human community with a shared future.

How to provide more equitable, inclusive, and high-quality education has become an important global issue [5]. Through the exploration of the past three years, GMA has gained some experience in promoting international cooperation in the online field and providing more open and high-quality education through joint teaching, capacity building, knowledge sharing, and public advocacy. In the future, GMA will continue to explore more diverse cooperation models, provide more support, and promote the construction of a global online learning community, so as to empower learners and teachers [8] and help achieve SDG 4.

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Optimizing the Design, Pedagogical Decision-Making and Development of MOOCs Through the Use of Ai-Based Tools

Miguel Morales-Chan, Héctor R. Amado-Salvatierra, and Rocael Hernández-Rizzardini

Universidad Galileo
7 av Calle Dr Suger Zona 10, Guatemala
amorales@galileo.edu | hr_amado@galileo.edu | roc@galileo.edu

This work explores the use of different generative AI tools in the design of MOOC courses. Authors in this experience employed a variety of AI-based tools, including natural language processing tools (e.g. *ChatGPT*), and multimedia content authoring tools (e.g. *DALLE-2*, *Midjourney*, *Tome.ai*) to assist in the course design process. The aim was to address the unique challenges of MOOC course design, which includes to create engaging and effective content, to design interactive learning activities, and to assess student learning outcomes. The authors identified positive results with the incorporation of AI-based tools, which significantly improved the quality and effectiveness of MOOC course design. The tools proved particularly effective in analyzing and categorizing course content, identifying key learning objectives, and designing interactive learning activities that engaged students and facilitated learning. Moreover, the use of AI-based tools, streamlined the course design process, significantly reducing the time required to design and prepare the courses. In conclusion, the integration of generative AI tools into the MOOC course design process holds great potential for improving the quality and efficiency of these courses. Researchers and course designers should consider the advantages of incorporating generative AI tools into their design process to enhance their course offerings and facilitate student learning outcomes while also reducing the time and effort required for course development.

1 Introduction

Massive Open Online Courses (MOOCs) have revolutionized traditional educational models by offering students flexible access to high-quality instructional content [4] . Effective instructional design is essential for meaningful and thorough learning, and MOOC design can engage students and facilitate such learning. Several instructional design models appropriate for online environments have been developed, including the models: *ADDIE*, Dick and Carey, Bates, Dabbagh, and Bannan-Ritland, and Morrison, Ross, Kemp, Kalman, and Kemp [2]. Despite standard design procedures, different instructional designs for MOOCs can result in varying outcomes. Therefore, the design of MOOCs should consider multiple perspectives, such as the learning environment, the learner cohort, the prior knowledge of the learners, the scaffolding, and social interaction among learners in order to accommodate a variety of learning circumstances and needs [8]. Authors in [1] conducted a study that classified MOOC design considerations into three major categories: resources, pedagogy, and logistics. MOOC design should incorporate key principles of instructional design, connectivist learning theory, and self-regulated learning strategies to ensure rigorous instructional design, promote social interaction, and enhance learners' self-direction and time-management abilities.

The use of generative AI tools in instructional design represents an interesting field of exploration. Such tools can assist instructional designers in multiple tasks, including content analysis, identifying learning objectives, designing interactive learning activities, and evaluating student learning outcomes. By analyzing and categorizing course content, generative AI tools can identify gaps and redundancies, and provide insights into learner preferences and behavior [3]. Previous courses and experiences can also provide valuable insights and opportunities to create new courses [7]. It is important to note that generative AI tools should not replace instructional designers; but rather support them in their job. Instructional designers must have a clear understanding of the learning objectives, learner needs, and course requirements before incorporating generative AI tools into the design process. This means that instructional designers must collaborate with generative AI tools to ensure that the course is tailored to the learners' needs. One of the biggest challenges of generative AI tools (e.g. *ChatGPT*) is that, while they can generate consistent and sometimes surprising responses, these responses may not always be accurate or reliable. The lack of context and limited training can lead to incorrect or inappropriate responses. Furthermore, using Generative AI tools requires instructional designers to have a certain level of technical expertise. They must understand how the tools work, what data they are analyzing, and how to interpret the results. This requires instructional designers to undergo training to develop skills to work with Generative AI tools effectively.

This paper describes the experience designing a MOOC using the help of generative AI tools. The specific tools employed are described, along with key considerations and best practices for optimizing the pedagogical decision-making, design, and development of MOOCs. The course "Transforming Education with Artificial Intelligence: How to Use ChatGPT in the Classroom" serves as a guide and provides examples for innovative educators interested in incorporating AI into their teaching methods. The experience of designing and developing the course provided teachers with valuable insights on how to enhance their pedagogical approach with generative AI tools. This work highlights the potential of generative AI tools in the design of MOOCs, particularly in the creation of educational resources as well as authentic and engaging learning experiences for learners from diverse backgrounds. In addition, the course is an invaluable resource for educators interested in exploring the educational potential of AI. The experience underscores the importance of integrating emerging technologies into pedagogical practice to foster meaningful learning experiences.

2 MOOC Course Design

The objective of the course titled "Transforming Education with Artificial Intelligence: How to Use ChatGPT in the Classroom" was to share fundamental knowledge on the integration of AI in education, with a particular emphasis on sharing practical examples of using prompts to help teachers maximize *ChatGPT*'s potential. The course focused on instructing participants how to correctly create prompts and use certain applications, including extensions and tools that utilize *GPT-4*. The course was designed with 25 short video lectures distributed across five modules. These modules included an introduction to *ChatGPT*, practical examples of how *ChatGPT* can be used effectively in the teaching process, AI-based content generation tools and *ChatGPT*, ethical and privacy challenges in the use of *ChatGPT* in education, reflections, and additional resources for further research. The course also identified the potential of generative AI tools as an integral part of the learning process. The role of the tools was to assist instructional designers with several tasks, including educational planning, learning planning, the creation of personalized instructional materials, the design of learning activities, and assessments.

To implement the course, the platform *Thinkific* was utilized. *Thinkific* is an online course platform that provides instructors with various tools for creating, marketing, and selling their courses. It includes a course creation tool, a website builder, a marketing and sales package, and tools for student engagement. The platform made it easy to distribute course materials, monitor student progress, and communicate with students. It provided an intuitive interface for participants to access course content and complete assessments. The course was taught in Spanish, and the response from Latin American students was overwhelmingly positive. The first cohort consisted of 1433 students, with 52 % being male and 48 % female. The majority of students were from Ecuador, Guatemala, and Mexico. The course's 15 percent completion rate indicates a high level of interest in the topic among the participants.

The methodology used to design the MOOC course with generative AI tools was meticulously crafted to ensure a highly efficient and effective design process. Beginning with the identification of learning objectives and course content, the process continued with the establishment of the MOOC structure design, including the determination of workload per module, learning objectives, syllabus, study guide, and timeline. *ChatGPT* played a crucial role in the development of the video's script and concept by recommending the most suitable video format, such as animations, infographics, talking heads, or screencasts, and assisting in identifying graphic elements that could highlight the course's core concepts. In addition, *ChatGPT* was utilized to generate PDF-formatted supporting documents, whereas *DALLE-2* and *Midjourney* were utilized to generate supporting images. *DALLE-2* is a state-of-the-art language model developed by OpenAI that can generate coherent and high-quality realistic images and art based on a given prompt. In this course, the designer used *DALLE-2* to generate initial versions of course graphical content and infographics, which allowed her to quickly generate engaging content reducing the need of a professional graphic designer. *Midjourney* is an AI-based tool that can generate suggestions for visual aids, such as infographics and charts based on a given prompt. By using this AI-based tools, the designers were able to quickly generate ideas for visual aids that helped to enhance the learning experience for the students. *Tomme.app* was used to create presentations, whereas *Play.ht* was used to create podcasts. *Tome.app* is a tool that uses AI to generate alternative text descriptions for images and storytelling and was used to generate the storytelling and alternative text descriptions for images used in our course, which helped to ensure that all learners were able to engage with the course content. Both *ChatGPT* and *Overleaf* were utilized to create mind maps, with *ChatGPT* also being used to create learning activities, self-assessment tests, and peer assessment tasks. Within a microlearning environment, synthetic videos were produced with the help of AI and served as instructional video content. Text-to-video (TTV) was produced with photorealistic synthetic images using the AI-powered video creation platform *Heygen*. *Heygen* created a synthetic clone of the teacher after establishing the photorealistic quality of the generated videos using multiple images of the teacher from different profiles and background scenarios. The synthetically generated video representation of the teacher that TTV input initiated received realistic gestures and movements thanks to neural video synthesis for the final production asset. Additionally, lip-sync feature of *Heygen* made it easy to create videos with a more authentic feel. The advanced features of *Heygen* have made content creation more efficient, empowering users to create high-quality, audience-engaging video content that generates results. In addition, *ChatGPT* was used to generate quizzes for summative assessment, providing a comprehensive evaluation of the students' learning outcomes. Table 1 outlines the learning resources developed and the tools used.

Table 1: Educational resource type and generative AI Tools used

Educational resource type		Generative AI tool used
Content creation	Video script	ChatGPT
	Video concept	ChatGPT
	Video production and post-production	Heygen
	Support images	DALLE-2
	Support documents PDF	ChatGPT
	Podcast	Play.ht
	Content presentations	Tomme.app
	Mind maps	ChatGPT+ Overleaf
	Learning activities	ChatGPT
Design of the communication tools	Asynchronous tools: forums, blogs, wikis	ChatGPT
Design of assessment activities	Self-assessment tests (formative)	ChatGPT
	Tasks for peer assessment (P2P)	ChatGPT
	Test (summative)	ChatGPT

The integration of generative AI tools into the process of designing MOOCs has demonstrated several benefits for this experience. The creation of highly engaging and interactive educational resources that cater to the diverse learning needs of students is a significant advantage. These tools utilize AI-based algorithms to generate educational content that adapts to the preferences and proficiency levels of individual learners. In addition, the incorporation of these tools in the experience has improved scalability, allowing educational content to be delivered to a larger audience.

As discussed previously, AI has the potential to enhance the effectiveness of certain MOOC design and development processes. Even though these tools can generate content rapidly and efficiently, human input is still necessary to ensure the quality and accuracy of course materials. It is essential to create effective prompts to align generated content with course objectives and ensure that it is appropriate for the intended audience. This requires a thorough understanding of the topic and the needs and preferences of the audience. Prompts are phrases or questions that are used to direct a language mode, such as *ChatGPT*, to produce a response [6]. The quality of prompts is one of the most important factors in achieving a successful conversation with AI-based tools. Well-defined and accurate prompts can help guide the conversation effectively, ensuring that the user's topics of interest are addressed. On the other hand, poorly defined prompts can generate unfocused and unproductive conversations, resulting in a less engaging and informative experience [8]. Therefore, it is crucial to pay attention to the quality of prompts and ensure that they are well constructed to achieve a successful conversation.

The quality and relevance of the prompts used can have a significant impact on the effectiveness of the response of the AI-based tool. In the context of instructional design for MOOCs, prompt engineering is a critical aspect of working with generative AI tools such as *ChatGPT*. To effectively communicate with AI-based tools, instructional designers must design prompts that are clear, concise, and relevant to the learning objectives of the course. In this context, we propose a set of prompt examples centered on the "educational field" that can be used in communication with *ChatGPT* to achieve better results.

(a) *Sequential prompts* aim to establish a logical progression in the conversation by employing a series of prior texts that permit a more elaborate and contextual response. To achieve this, they are organized in a logical order that guides the communication towards a particular goal. In the educational field, for instance, a sequential prompt can be used to ask the AI to describe the evolution of education over the past 50 years and how it has influenced educational innovation, followed by a question asking the AI to identify two examples of innovative technologies that have transformed education and explain how they function. Finally, the AI could be prompted to compose a concise article that synthesizes the aforementioned information and adds two examples of innovative technologies that have revolutionized education. This type of prompt enables a more elaborate and structured communication, which can be extremely beneficial in the field of education.

On the other hand, the (b) *comparative prompt* asks the AI to compare two or more things and/or situations in order to produce more precise results. For example, the AI could be asked to compare the effectiveness of online education with face-to-face education in terms of learning and motivation. It could also be asked to compare two innovative teaching methods and explain which one is more effective and why.

(c) The *argumentative prompt* intends for the AI to generate a coherent argument or position on a specific topic. In this type of prompt, there is typically a direct request for the AI to argue for or against an idea using previously supplied information. For example, the AI could be asked to argue why it is important to implement educational innovation today or to argue against online education and explain why face-to-face education the most effective option is still.

One of the most common types of dialogue generation prompts is (d) the *professional perspective prompt*, which requires the AI to assume the role of a particular person or profession and describe a topic within a given context. It has been demonstrated that using professional perspective prompts improves the quality of responses generated by language model-based dialogue systems. The suggested structure for professional perspective prompts is "Act as [author or profession] and describe [topic] + context," allowing *ChatGPT* to assume a particular role and provide a more detailed, objective, and structured response. For example, a professional perspective prompt could read, "Assume the role of a public health expert and explain how the current pandemic could be addressed through public policies".

(e) *Wish list prompts* are another commonly used structure for obtaining more specific and relevant responses from *ChatGPT*. By providing a list of specific requirements that need to be met, users can provide detailed information about their needs and preferences, which allows *ChatGPT* to provide a more precise and focused response. The suggested structure for wish list prompts is "I am looking for [option/object/solution] with [requirement 1], [requirement 2], and [requirement 3]. Could you recommend some ideas?" For example, a wish list prompt could be "I am looking for a gamification tool to improve student engagement in my online classes, with student progress tracking and the ability to customize content. Could you provide me with a list of some applications that meet these requirements?". As AI continues to advance, the potential of technology to transform education is increasing. In [5], a collection of prompts for instructional design is presented. In addition to the prompts, new ways of using chatbot and *ChatGPT* technology in education are being researched, such as creating personalized virtual tutors, gamification, and dialogue-based learning.

It is important to note that while AI can streamline certain aspects of content creation, it cannot replace human expertise entirely. It is essential to strike a balance between AI-generated content and human input in order to develop effective educational materials in the digital age.

3 Conclusion and Future Work

Future work in the field of instructional design and generative AI tools for MOOCs is promising. One area of potential future work is the application of natural language processing (NLP) to enhance the effectiveness of AI-based tools. NLP can improve the accuracy and relevance of responses provided by AI-based tools, making them more valuable for learners. Additionally, ongoing research focuses on developing more advanced generative AI tools that can adapt to the individual learner's needs and preferences. It is also crucial to ensure that generative AI tools can be trained on real data from courses prepared by the institution's teachers to maintain the editorial line and maintain consistency and a similar style.

Another area of future work is the establishment of best practices for integrating generative AI tools into instructional design. As the use of generative AI tools becomes more widespread in MOOC design, it is essential to develop standardized approaches and guidelines for their implementation. This will help ensure that the tools are used effectively and that the resulting courses are engaging and effective for learners. In conclusion, the use of generative AI tools in instructional design for MOOCs has the potential to revolutionize the way courses are designed and delivered. By leveraging generative AI tools such as *ChatGPT*, instructional designers can reduce the time and effort required to develop courses while also improving the engagement and effectiveness of the resulting courses.

However, it is important to note that the use of generative AI tools requires a deep understanding of the learning objectives and the learners' needs. Moreover, effective communication with generative AI tools requires prompt engineering, data selection, and ongoing monitoring and evaluation. As the field of AI-based instructional design continues to evolve, there is a need for ongoing research and the development of best practices to ensure that generative AI tools are used effectively and that resulting courses are engaging and effective for learners.

Acknowledgment

The authors acknowledge PROF-XXI, an Erasmus+ project funded by the European Commission (609767-EPP-1-2019-1- ES-EPPKA2-CBHE-JP). This publication reflects the views only of the authors.

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Modularization of Open Online Courses on the eGov-Campus

Prospects and Challenges

Marc Egloffstein[1], Holger Hünemohr[2], and Dirk Ifenthaler[3]

[1] University of Mannheim
egloffstein@uni-mannheim.de
[2] RheinMain University of Applied Sciences
holger.huenemohr@hs-rm.de
[3] University of Mannheim and Curtin University
ifenthaler@uni-mannheim.de

Modularization describes the transformation of MOOCs from a comprehensive academic course format into smaller, more manageable learning offerings. It can be seen as one of the prerequisites for the successful implementation of MOOC-based micro-credentials in professional education and training. This short paper reports on the development and application of a modularization framework for Open Online Courses. Using the example of eGov-Campus, a German MOOC provider for the public sector linked to both academia and formal professional development, the structural specifications for modularized MOOC offerings and a methodology for course transformation as well as associated challenges in technology, organization and educational design are outlined. Following on from this, future prospects are discussed under the headings of individualization, certification and integration.

1 Introduction

More than a decade after inception, Massive Open Online Courses (MOOCs) have become an important element both for academic degree and professional certificate programs [7], blurring the boundaries between these formerly separate spheres [9]. In fact, MOOCs have become a viable alternative for corporate training and professional development [3, 5]. Considering that factors such as high dropout rates or instructional quality remain central to MOOC research [2], there seems to be room for improvements in MOOC design. In line with trends like microlearning instruction [13], mobile microlearning with MOOCs [1] and the shift towards micro-credentials [6], transforming MOOCs from an academic course format into smaller learning offerings in the sense of “mini-MOOCs” [11] seems to be a coherent alternative, both for learning design and organizational reasons. While some effects of a “modularization” of open online courses on learner behavior have been researched [10], there is still no clear methodology on how to achieve such a transformation. Therefore, this short paper reports on the experiences from a transformation and re-design project with a MOOC provider in Germany linked to both academia and formal professional development. Based on the overarching question, “how can MOOCs be meaningfully transformed into more manageable units?”, we present a modularization framework with its structural specifications and a reference model for implementation. Subsequently, future prospects as well as organizational, technical and educational design related challenges of course modularization are discussed.

2 Research Context: the eGov-Campus

The eGov-Campus (https://egov-campus.org) is a learning platform that offers open online courses (MOOCs) for education and training in the public sector in Germany. Its academic level learning offerings center around topics of digital transformation in administration.

In a decentralized project organization, eGov-Campus courses are designed, implemented and administrated by a range of different academic institutions. Coordination meetings help to meet external requirements and to align the curriculum. An active, partially formalized community (bi-weekly meetings, community management) of researchers involved in the eGov-Campus drives the development and research of the platform and takes responsibility for supporting activities such as marketing. By early 2023, 18 courses are available free of charge in open access on the platform, addressing topics like “Process Management in the Public Sector” or “Open Government”. eGov-Campus MOOCs are integrated into different educational contexts and recognized in both academia and professional development for public administration.

To better meet stakeholder requirements and enable more flexible learning designs, a project to modularize eGov-Campus courses was launched in mid-2022. In this context, modularization describes the division of existing courses into smaller, self-contained, combinable and competence-oriented learning offerings. The primary goals of the modularization project are:

- Facilitated integration of eGov-Campus content into various higher and continuing education scenarios.

- Content differentiation, enabling learners to prioritize according to their own professional role and associated qualification requirements.
- Curricular restructuring of existing offerings, including the establishment of an introductory block.
- Implementation of micro-credentials for learning offerings below the course level.

3 Modularization Framework

3.1 Structural Specification

Due to definitional ambiguities, the introduction of a unified structure and terminology represents the necessary first step in the modularization project. The specification follows a pragmatic approach that ensures consistency with established terms as well as scientific terminology. Figure 1 shows the concepts used and their structural relationships in simplified modeling [12].

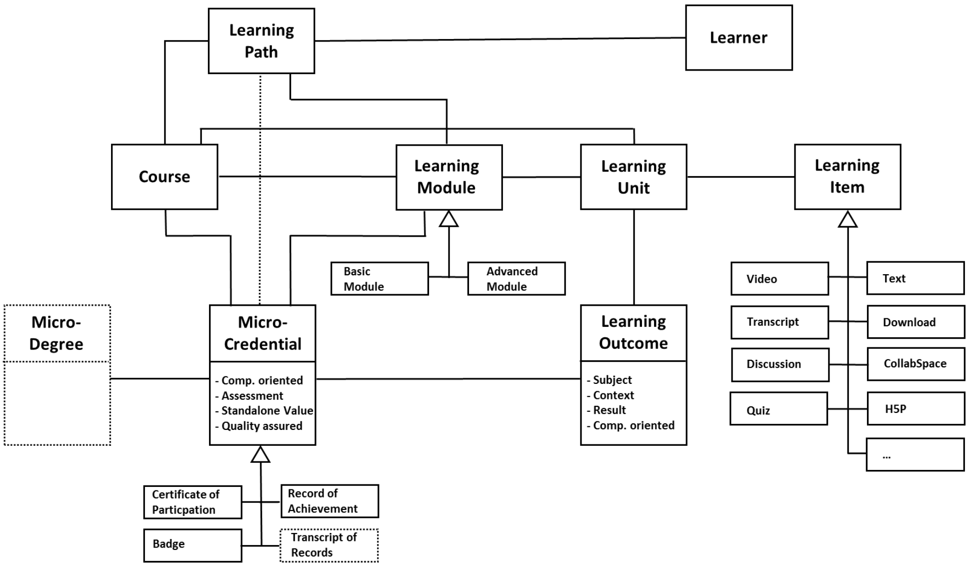

Figure 1: Structure of the modularized eGov-Campus offerings

The central element of the modularization approach is the concept of a “learning module”, that is: a learning offering below the course level (in terms of duration and effort) that can be accessed independently on the platform. Learning modules consist of several learning units linked to learning outcomes and are associated with micro-credentials. Learning modules can either be basic modules (introduction and foundations) or advanced modules (specialization and deep-dive), which represents a major curricular transformation. The newly introduced basic modules offer an overview of the subject area and provide orientation and assistance for further studies in order to mitigate initial difficulties and counteract dropouts.

3.2 Reference Model for Implementation

To enable the transformation and re-design of existing courses, a heuristic ten-step process model for course designers has been outlined:

1. *Initial delimitation of learning modules*
   The initial delimitation of the future basic and advanced modules is based on content-related (consistent units) and organizational (appropriate effort, comparable specifications) considerations. The modules have a duration of four hours (equals half a study day) or eight hours (equals one study day).

2. *Design of the basic module*
   The learning outcomes, content, activities and assessments (if applicable) for the basic module (foundations and introduction) are specified. The basic module has an effort of eight hours (equals one study day). Adaptations for the target group “training and further education” are made (e.g. additional real-world examples or similar).

3. *Specification of learning outcomes*
   To ensure competency orientation, learning outcomes are formulated for the advanced modules to be implemented.

4. *Specification of learning units and learning items*
   The learning items (contents, activities, assessments) required for the implementation of the learning outcomes are specified. At the same time, the different learning units (as parts of the advanced modules) need to be delineated.

5. *Examination and modeling of dependencies between and within advanced modules*
   The advanced modules represent self-contained learning offerings that can be completed individually. In the course of modularization, (potential) dependencies between learning modules and between learning units within a learning module must be taken into account. In doing so, entry requirements, possible

connections, the level of difficulty, content depth vs. breadth as well as questions of sequencing (linear vs. parallel processing) must be taken into account. Furthermore, interdependencies within and between the new modules in terms of learning design must be considered and, if necessary, adapted (e.g. in the case of continuous case studies).

6. *Metadata for learning modules*
   Based on the previous steps, the learning modules (basic and advanced modules) are described with metadata necessary for assigning them to learning paths. A corresponding template is provided.

7. *Implementation and transformation on the learning platform*
   The learning modules are implemented on the learning platform, according to the current planning status as separate course entities. Based on the previous analyses, learning items are curated (if necessary added, changed, or omitted). Adjustments to the content will be made if necessary.

8. *Specification of learning paths*
   Based on pre-defined profiles within the target group, learning paths (i.e. sequences of different learning modules) are specified and assigned to the profiles.

9. *Validation of the course transformation (modularization workshops)*
   The delineation of learning modules, assignment to profiles, and the specification of learning paths are validated within the eGov-Campus community and with external experts. For each new offering (i.e. modules series as bundles of basic and advanced modules, either based on existing courses or newly developed), a modularization workshop is carried out, where the responsible subject matter experts and their teaching team discuss the results with stakeholders.

10. *Re-design and quality assurance*
    Based on the feedback, adjustments to the modularization are made if necessary. Ongoing quality assurance is carried out on the basis of feedback from the evaluation. The necessary instruments are provided. Users are involved in the follow-up process as far as possible.

3.3 Design and Development Process

Following an Educational Design Research approach [8], the transformation of three existing courses is being implemented in a joint development effort. A small project team consisting of course designers, teaching assistants and additional educational design support is currently working on prototypical implementations.

In the process, there is feedback from the eGov-Campus community and additional external stakeholders, which has already led to adjustments of the framework. As a short term result of this pilot phase, design guidelines will be derived for providers of existing and developers of future eGov-Campus courses. Likewise, the newly introduced learning modules will serve as proof of concept for the modularization approach and methodology. In the medium term, the modularized offering will allow for the implementation of different tracks within the (former) course offerings, enabling differentiation with regard to different target groups in the context of public administration.

4 Discussion and Outlook

Modularization can be a means to address some of current the organizational and educational challenges associated with MOOCs. Learning Modules can provide the desired flexibility for non-academic learners as well as additional opportunities for tailoring and blending learning offerings. In this paper, we have outlined an approach to implementing course modularization using the example of the eGov-Campus platform.

Currently, the modularization project faces a number of challenges in different areas. *Challenges related to the educational design* primarily stem from the change of perspective necessary when also focusing on practitioners. Course designers need to find the right balance between academic style teaching and learning and the affordances of further education in every aspect of learning design (content, activities, assessment). There is also a need for a specific learning design for smaller educational offerings that goes beyond the traditional xMOOC-model (i.e. video plus quizzes). Finally, the content differentiation according to target groups (different roles in the public sector, like manager, IT-specialist etc.) is still subject to further considerations. *Organizational challenges* essentially revolve around the subject of certification. The task is to design learning modules that will be recognized with both academic credit and formal training days. Furthermore, the type of credentialing, be it with the existing credentials "certificate of participation" and "record of achievement" or additional proofs like digital badges must be specified. There is still a lot of conceptual groundwork to be done for the design of micro-degrees, even though initial approaches from related projects can be taken into consideration [4]. *Technical challenges* relate to the means of implementation: Which existing functions of the underlying MOOC-platform can be used; which additional functions would have to be incorporated? How can learning modules be implemented, wrapped or bundled? How can learning pathways be mapped on the platform? How can a transcript of records be implemented?

Once these challenges are addressed, modularization can pave the way for some important further developments of open online learning which can be summarized under the keywords *individualization*, *certification* and *integration*. Modularization opens up the opportunity to follow different tracks within a (former) course or individual learning pathways over learning modules from different subject areas. With future recommendation engines or elaborate adaptive learning systems, a truly individualized learning experience will be possible. A modularized certification system opens up the opportunity of collecting digital proofs and micro- credentials and aggregating them into micro-degrees that can eventually be incorporated into modular online degrees. From a conceptual perspective, smaller learning modules can be more easily integrated into open ecosystems like digital education spaces such as the planned national education platform.

Taking these challenges and prospects into account, the design and prototypical application of a modularization framework can be an important step in the further development of eGov-Campus MOOCs that may well point beyond the context under consideration.

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Using Analytics in a Large Virtual Classroom for Open edX

Fred Dixon[1] and Stefania Trabucchi[2]

[1] BigBlueButton Inc.
[2] Abstract-Technology GmbH

The main aim of this article is to explore how learning analytics and synchronous collaboration could improve course completion and learner outcomes in MOOCs, which traditionally have been delivered asynchronously. Based on our experience with developing BigBlueButton, a virtual classroom platform that provides educators with live analytics, this paper explores three scenarios with business focused MOOCs to improve outcomes and strengthen learned skills.

1 Introduction

BigBlueButton is an open-source virtual classroom platform that provides the educator – the teacher, instructor, or professor – with analytics that gives insight into student performance during the class. BigBlueButton is designed for education, covering scenarios of tutoring, small classes, group collaboration, and larger classes with hundreds of students. BigBlueButton integrates with Open edX via Learning Tools Interoperability 1.0/1.1 (LTI).

Open edX is an open-source learning management system (LMS) and online courseware platform. It empowers individuals and institutions to offer online education at scale, facilitates knowledge sharing, and fosters lifelong learning opportunities. Data-driven insights can be collected using Open edX to analyze data on learner interactions, performance, and progress. This data can be used by educators and administrators to refine teaching strategies.

Massive Open Online Courses (MOOCs), such as those enabled with Open edX, are open to thousands of students and, as such, are mostly conducted asynchronously. A challenge with the MOOC format is the average completion rate for online courses teeters around 5–15 % and the dropout rates are high [3].

This paper looks at how synchronous collaboration (virtual classes) with learning analytics could improve course completion rates of MOOCs, especially in the business context, and increase mastery of new skills.

2 The Challenge of Virtual Classrooms

During Covid-19, most virtual classes were taught using business-focused video platforms. These platforms focus on sharing screens and webcams with limited built-in assessment. However, the goal of the virtual classroom is not to meet, it is to *learn* [4]. In contrast, we designed BigBlueButton based on two foundations:

1. Based on pedagogical theory, BigBlueButton focuses on maximizing time for applied learning activities and receiving feedback during the class.
2. BigBlueButton provides live analytics to enable the educator to easily assess the performance of the class, and of individual students, leading to meaningful insight on which students were struggling (or excelling).

3 Applied Learning vs. Passive Learning

When students attend a class, whether in person or online, their goal is to efficiently achieve mastery. Pedagogy – the science of teaching and learning – tells us that our brains learn in stages. Bloom's Taxonomy describes six stages of learning that we "climb" towards mastery (referred hereafter as "Bloom's Staircase") [2].

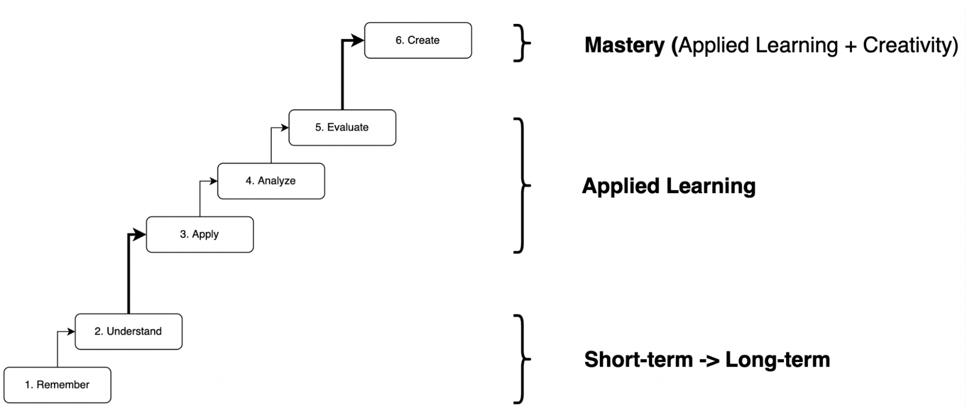


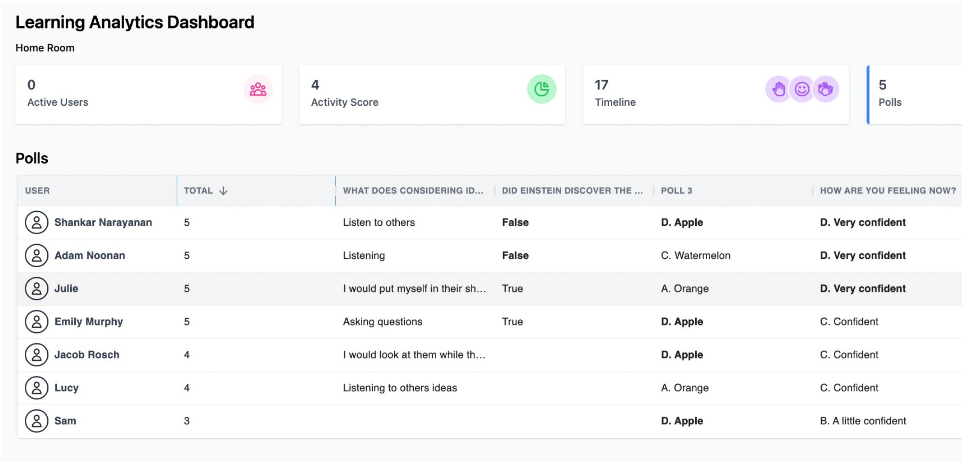
Figure 1: The six stages of Bloom's Staircase.

Three of Bloom's stages focus on applied learning – apply, analyze, and evaluate. Specifically, these stages focus on applying knowledge to a task, measuring the outcomes, and judging the results ("Did I get the right answer/outcomes from the task?"). Applying knowledge takes mental effort, deep thinking, and a bit of struggle – and, importantly, that struggle creates new synapses in our brains. In contrast, passively watching a YouTube recording or a one-way class requires less engagement and, consequently, yields less learning.

Too much struggle, however, can be frustrating, especially if the student feels blocked. If a student receives timely feedback – either from the instructor (one-on-one) or peers – they can overcome the blockage, reach new levels of understanding, and climb Bloom's staircase. But how can the instructor know if students are struggling?

4 The Value of Learning Analytics in the Virtual Classrooms

Learning Analytics is defined as: "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs" [6]. Using real-time analytics during the lecture, the instructor could see the results and summary of testing students and adjust the pace of their lecturing [5].



USER	TOTAL	WHAT DOES CONSIDERING ID...	DID EINSTEIN DISCOVER THE ...	POLL 3	HOW ARE YOU FEELING NOW?
Shankar Narayanan	5	Listen to others	False	D. Apple	D. Very confident
Adam Noonan	5	Listening	False	C. Watermelon	D. Very confident
Julie	5	I would put myself in their sh...	True	A. Orange	D. Very confident
Emily Murphy	5	Asking questions	True	D. Apple	C. Confident
Jacob Rosch	4	I would look at them while th...		D. Apple	C. Confident
Lucy	4	Listening to others ideas		A. Orange	C. Confident
Sam	3			D. Apple	B. A little confident

Figure 2: A tabular view of BigBlueButton's Learning Analytics Dashboard showing answers to polls.

BigBlueButton provides the educator with a Learning Analytics Dashboard ("LAD") that gives data on attendance, participation, and learning (based on poll responses) (see Figure 2). BigBlueButton computes an "activity score" based on total time spent speaking, chatting, raising hands, using emojis, and responding to polls. Using this score, along with responses to pools, instructors can pinpoint which students may be struggling and give feedback in the moment.

5 Using Live Collaboration and Analytics to enhance a Business-focused MOOC

Both BigBlueButton and Open edX have analytics, and we see the potential for unifying analytics from both, giving educators a unified view of how students learn in both modalities: self-directed and virtual classrooms. A unified view would make it easier for educators to understand if and why students do not complete the course, achieve low learning outcomes, and ultimately give educators insight to improve the overall experience of the course.

We envision three scenarios where synchronous collaboration and analytics could benefit MOOCs:

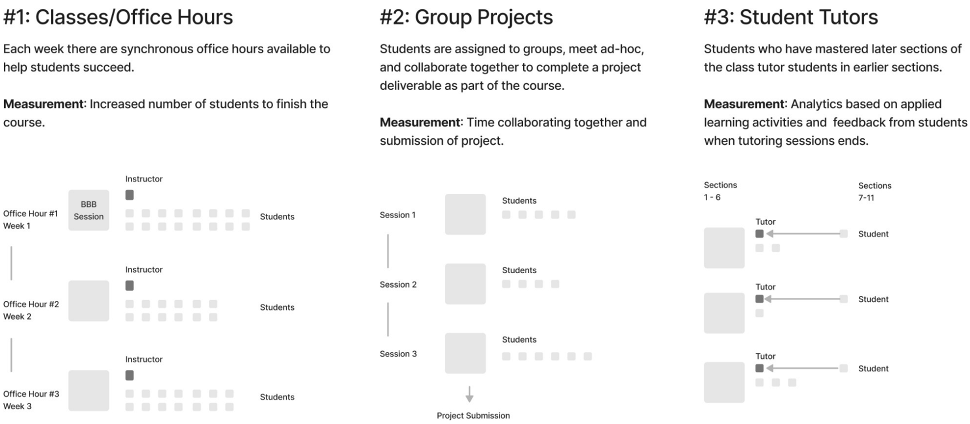


Figure 3: Three scenarios for synchronous learning in a MOOC

5.1 Scenario #1: Classes/Office Hours

Consider a company offering a MOOC on statistics. For virtual classes/office hours, analytics (not webcams) would help the educator gauge the effectiveness of applied learning activities during the class. For example:

- **Chat**: Ask students to give examples of where knowing the medium would be helpful. Students can also anonymously vote on the suggestions of others. *Analytics: Which students gave examples, up-voted other examples, and received the most votes for their example.*
- **Quiz**: Present a slide giving a list of numbers and asking, "Which number is the median?" *Analytics: Track which students correctly answered the quiz and how quickly they answered.*
- **Breakout rooms** (group assignment): Give each breakout room a random list of numbers and ask students in the breakout room to calculate the mean, median, and mode. *Analytics: live monitoring of activity in each breakout room discussion (talking, chatting, using the whiteboard).*

For large classes, the analytics could plot groups of students along two axes: activity and formative assessment (i.e. quiz results), giving the educator a way of seeing if the whole class, or groups, are struggling.

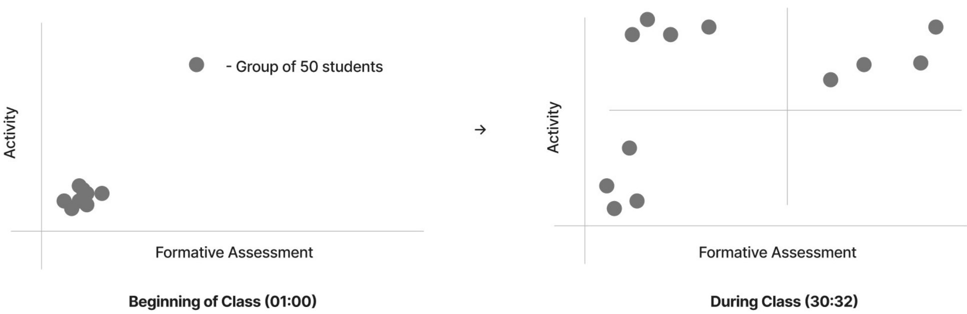


Figure 4: Design for measuring activity vs learning in a live class.

In Figure 4, halfway through the class at 30:32, the live analytics show the class separating into three groups: (1) students that have low participation and a low score on the formative assessment, (2) students who have participated in the activities, and are showing more progress, and (3) students who are participating and who are showing good results in formative assessment. These live analytics would help the educator better adapt teaching for the remainder of the class.

5.2 Scenario #2: Group Projects

In this second scenario, the course could support group work. Based on social constructivism, the course would require (and track via analytics) synchronous sessions where students work together to apply their skills. The measurement for success is the time spent collaborating and grading the submission which could be shared with Open edX or with a Learning Record Store ("LRS") via xAPI.

5.3 Scenario #3: Student Tutors

In this third scenario, which is more novel, we envision structuring the MOOC so that students earlier in the course receive tutoring from students later in the course. Students who receive the tutoring would have lower drop-out rates, and students who give the tutoring would strengthen their understanding of the content. And as MOOCs have no specific enrollment, there will always be students at various stages of the course. This scenario is novel as no instructors are needed.

The analytics from the tutoring sessions (time tutoring and activity score) – along with exit scoring from students when the session ends – would provide Open edX enough data to credit the tutors for the time and assess performance.

An advantage of this approach is that students are expected to apply their knowledge, to receive help and to give help, thereby strengthening their understanding and ability to apply the knowledge in other areas of their job.

5.3.1 Deeper integration with Open edX

Integration of Open edX and BigBlueButton, both open-source platforms and focused on improving learner outcomes, offer opportunities to share analytics and give educators deeper insights into how learners are interacting with each other and with course content, and, at the course level, identify areas for improvement. For example, today Open edX supports analytics for text, video, and assessment components (see Figure 5).

This dashboard is computed by aggregate grading and scores along with active logins to last activities. Such analytics could be extended by incorporating analytics from synchronous sessions outlined in the previous scenarios.

With the onset of COVID-19 Anant Agarwal, the chief open education officer of 2U/edX, said that the future of learning is blended [1]. In fact, we need an online learning model to give students the option to progress at their own pace fully online. With Open edX as LMS, it is easy for students to look back on some

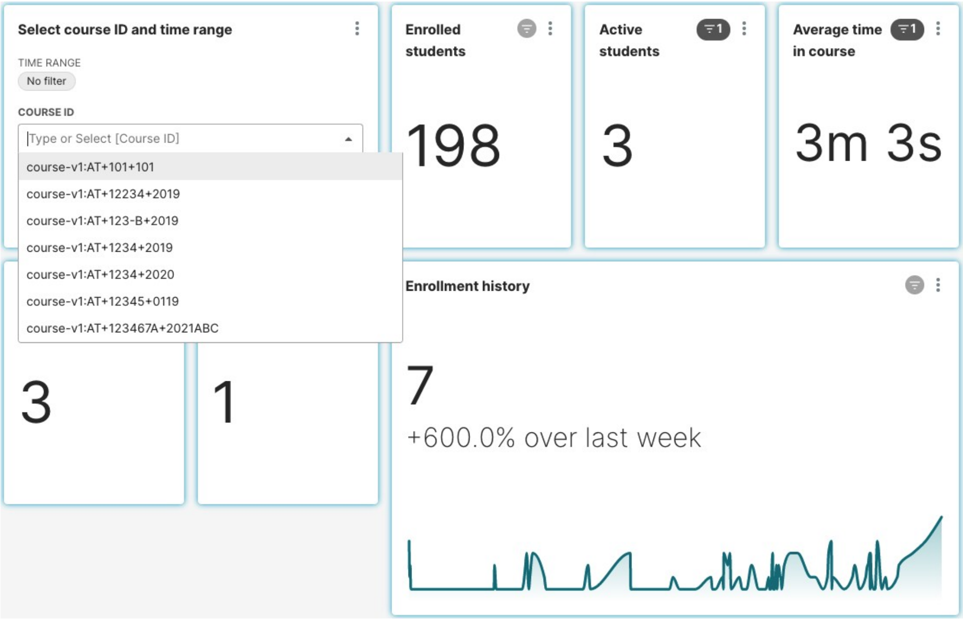


Figure 5: Dashboard analytics in Open edX.

materials and move ahead independently. Our belief is that education software should also enhance student collaboration.

While we don't want to counter Agarwal's statement that he did so much for online education, today, after almost three years of Covid, we would say that "**the future of learning is collaboration.**"

6 Conclusion

We see potential for improving course completion and learning outcomes by building analytics and synchronous collaboration into MOOCS. By aggregating analytics from BigBlueButton and Open edX together, for example, we can give educators and administrators a unified view of how the students learn in both modalities – self-directed and virtual classroom – and, in turn, improve the overall effectiveness of MOOCs for companies.

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Visualizing students flows to monitor persistence

Mehdi Khaneboubi

Université Paris Cité, EDA, F-75006 Paris, France
mehdi.khaneboubi@gmail.com

Founded in 2013, OpenClassrooms is a French online learning company that offers both paid courses and free MOOCs on a wide range of topics, including computer science and education. In 2021, in partnership with the EDA research unit, OpenClassrooms shared a database to solve the problem of how to increase persistence in their paid courses, which consist of a series of MOOCs and human mentoring. Our statistical analysis aims to identify reasons for dropouts that are due to the course design rather than demographic predictors or external factors. We aim to identify at-risk students, i.e. those who are on the verge of dropping out at a specific moment. To achieve this, we use learning analytics to characterize student behavior. We conducted data analysis on a sample of data related to the "Web Designers" and "Instructional Design" courses. By visualizing the student flow and constructing speed and acceleration predictors, we can identify which parts of the course need to be calibrated and when particular attention should be paid to these at-risk students.

1 Introduction

Founded in 2013, OpenClassrooms is a French online learning company that provides both paid courses and free MOOCs covering a wide range of topics, including computer science and education. In 2021, OpenClassrooms partnered with EDA research unit to share a database, aiming to address the challenge of studying persistence in their paid courses, which consist of a series of MOOCs, projects, and human mentoring. Accurately predicting dropouts early allows course designers and educators to adjust their teaching methods. This raises the question of finding predictors that can explain dropout and persistence.

Kizilcec et al. (2013) [8] presented a list of dropout predictors based on student activity features to predict which students are at risk of dropping out in three computer science MOOCs. They identified four engagement profiles based on variables such as demographics, forum participation, video access, and overall experience reports. Halawa and al. (2014) [7] demonstrated that performance on assessments, skipping assessments, skipping videos, and falling behind on watching video lectures are predictors of the likelihood of dropping out. Wei et al. (2023) [10] explained perceived learning outcomes with several predictors, including course design, interaction with instructors and peers, engagement in learning activities, and application of cognitive and metacognitive learning strategies.

Numerous researchers have described machine learning methodologies that predict dropout in online training [9, 12, 5, 3]. They define at-risk students according to the needs of machine learning methods. They center the definition of variables to be explained in relation to the availability of descriptors in their data and the requirements of machine learning algorithms. Evans and Baker (2016) [6] assess several definitions of persistence based on data collected from ten Coursera MOOCs. They observed different values for persistence according to their definition, but the pattern of high variance across measures remained the same. How persistence rates are calculated reflects differences in student goals for participating in a MOOC. They concluded that important factors explaining persistence are: first, the time when the video are published and the lexicon used to describe it, and then, the level of the course: as in university education, students tend to avoid assignments that require high levels of writing.

In a preprint document [4], Chibaya et al. (2022) present categories of situations for unsuccessful higher education students, which include:

- Permanently quitting from studies (dropout)
- Temporarily discontinuing studies with the hope of re-registering (stop-out)
- Responding to chronic stress through emotional and physical exhaustion (burnout)
- Enduring through a study program without success to the exam (failing)

They clearly present the situations that could occur but do not define the "at-risk" concept. In fact, being "at-risk for a student" depends on the student's profile in relation to the content being taught and the pedagogical setup of the training. It seems difficult to define it in an universal way, but it could be done by describing the training and the profiles of the students.

However, we can search for the specific behaviors of students who are highly likely to drop out. What are the first signs of weakness? Atif et al. (2020) investigated the perspectives of teachers regarding an early alert system in face-to-face training using Moodle [1]. The teachers' statements revealed that there is no standard approach to identifying at-risk students, including class attendance, assessment submissions, assessment types, and forum participation. However, the most commonly reported predictors by teachers are the submission of first assessments and assignments, as well as the achievement of certain grades. Wolff et al. (2013) [11] made a data analysis on click behavior of students in online training. Their primary finding is that a change in student behavior is the best predictor of dropout. If a student stops logging into the platform, there is a higher likelihood of dropout than for a student who initially has a low level of activity.

The context of our study differs from the researches cited above. Firstly, the OpenClassrooms training is entirely online and is based on a series of MOOCs that are not compulsory, but rather available as resources. Secondly, learners work individually and have flexible time frames to start and complete their training. Unlike traditional distance learning courses, students are not grouped into cohorts. As a result, we adopt Bruillard's (2017) [2] perspective that MOOCs should be considered as learning materials, rather than as online courses. In our context, access, attendance, and recognition have a different nature compared to traditional distance learning courses. In essence, MOOCs are dynamic websites made of text, videos, audios, social interactions, online communities, video conferences, and other features. This viewpoint of MOOCs enables us to differentiate the factors and standards that constitute the training in a novel manner.

2 Data and Method

The OpenClassrooms training program is designed to allow students to start and progress through the training at their own pace. To successfully complete the program, students must complete seven projects[1], which are evaluated by a mentor and defended in front of a jury. These projects must be completed in sequential order. Mentors are providing guidance and are assessing the quality of the work before the student is permitted to defend his work. Mentors are experts in their respective fields, possessing a deep understanding of the course content. Among the courses offered, the *Web Developer* course is the most popular, while the *Pedagogical Engineer* course has a smaller audience.

A unique database was accessed for the *Web Developer* training, which provided a sample dataset of 2995 students described by 59 variables. The primary explanatory variable in our analysis is the status variable, as shown in Figure 1.

There are three categories that describe dropout: churners, expired, and abandoned. Initially, we used these categories to define and identify at-risk students, i.e. those for whom the probability of dropping out could be predicted. Subsequently, we explored statistical associations between these students and other variables with

[1] The projects are: "Take charge of your web developer training", "Turn a template into a web site", "Make a web page dynamic with CSS animations", "Optimize an existing website", "Build an e-commerce website", "Build a secure API for a restaurant review application", "Create an corporate social network".

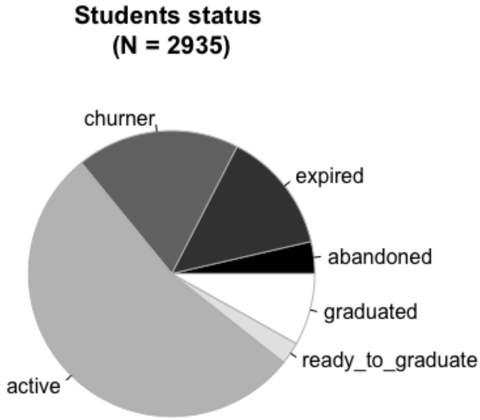

Figure 1: Student status for the *Web Developer* training

the ultimate objective of establishing predictors of dropout based on their online behavior.

Defining and identifying at-risk students is crucial for characterizing the problem and designing indicators to inform educational action. Exploring statistical associations between these students and variables in the database offers the possibility of constructing statistical predictors.

It is relevant and important to view the dataset as a snapshot of the training dynamics. The training process can be conceptualized as a progression of students navigating through projects, resources, and assignments. Therefore, it is necessary to identify and characterize typical movements of students, regular patterns in the course of training, and similar behavior that reveal organization and the opportunity for intervention at a specific moment. The objective of this study is to identify at-risk students and make possible special support when they require it the most.

3 Results

3.1 Representing at-risk students

Crossing the variable that characterizes the students' situation (active, certified or almost, and dropped out) with the start date of the training permit to draw Figure 2 diagram.

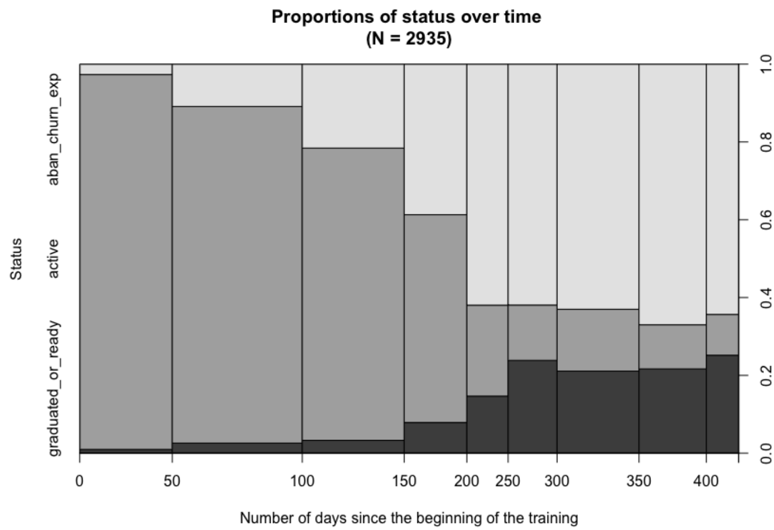

Figure 2: Proportion of students according to their status over time

The lighter gray area in Figure 2 represents the proportion of students who have dropped out, while the darker gray area represents those who have been certified or are in the process of certification. The middle area illustrates active students. The diagram shows that the proportion of students dropping out increases from 0 to 200 days after the start of the training, and thereafter stabilizes. When viewed as a snapshot in a continuous flow of collective movements, "at-risk" students are those represented just above the lower part of the light gray area. For these students, the probability of dropping out in the next period is higher than for others.

Table 1 corresponds to Figure 2 and shows that 267 students dropped out between 50 and 200 days into the training.

Table 1: Student status according to time since the beginning of the training

	[0,50)	[50,100)	[100,150)	[150,200)	[200,500)
aban_churn_exp	10	63	99	105	776
active	387	511	336	153	182
graduated_or_ready	4	14	16	20	259

This data can be interpreted as temporal milestones: the dropout rate rises every 50 days of training and plateaus at 200 days. These time intervals can be viewed as the most critical points for intervention to prevent dropout.

3.2 Visualizing pathway

Figure 3, presented below, displays, in row, projects that must be completed in order to succeed in the course. Time periods are represented in columns (0 to 50 days since the start, 50 to 100 days, etc.). Student status is indicated by colored dots: active students are represented in green, while those who have been inactive in the course are colored in red.

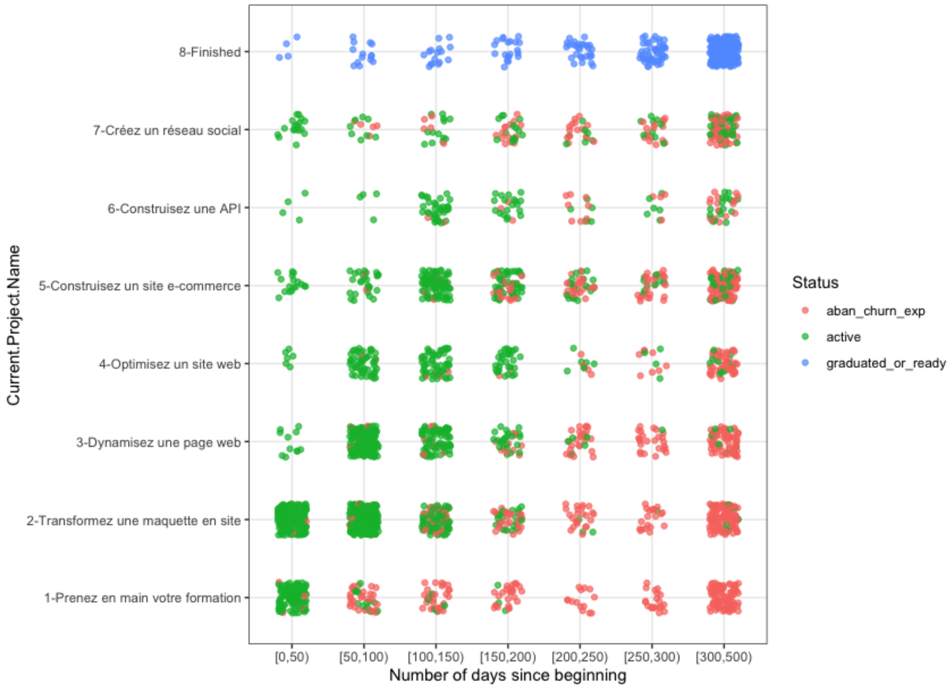

Figure 3: Distribution of students according to their achievement, the number of days in the training, and their status.

This scatter plot has to be seen as a checkerboard-style board. The bottom left square represents students who started their training less than 50 days ago and must complete the first project named "1-Taking in charge of your training". It is mostly green, indicating that the students are active. From a flow or stream perspective, this box is the source of the flow, and the flow direction is towards the highest row in which all projects have been completed, represented in blue. As time progresses, each dot will move to one of the three consecutive squares: on the upwards or top right square if the first project is made, on the right square if not.

In this perspective, the overall flow of students starts from the southwestern square and proceeds northward with an attraction towards the east of the representation. The more vertical a student's pathway is, the faster they will have completed the projects. The more horizontal a student's path is, the longer their training will take, and the more likely they are to drop out. This is evident by observing the strong concentrations of green dots that remain in the first three columns, as well as the strong concentrations of red dots located in the southeastern part of the graph, in the lower part of the last three columns.

Therefore, we can define at-risk students as those whose trajectory is more oriented towards the east of the graph, while successful students are those whose trajectory is more oriented towards the north.

3.3 Instantaneous and average speeds

We have re-established our collaboration with OpenClassrooms to improve the characterization of student flows. We obtained data from the *Educational Engineer* course and realized that the variable used to define student activity in our previous analysis was not very robust. Defining online or offline activity for infrastructure services is not straightforward. Therefore, we chose to define activity ourselves using a new database that is updated every three weeks. This allows us to extract training data and generate reports every three weeks. Using these databases, we calculated the instantaneous speed per student, as shown in Figure 4 below, which should be viewed as a checkerboard similar to Figure 3.

In this figure, green dots represent students with the highest speed, orange dots indicate the slowest, and grey dots show students without a speed calculation so far. We observe a pattern similar to a coastline from the southwest to the northeast of the graph. The fastest students in the last month is colored in green and is the closest part of this coastline, while the slowest students are located in the southeast part, colored in orange.

From a methodological standpoint, this calculation is possible with at least two datasets extracted at different moments during the training. With at least three extractions, we can calculate an average speed, as shown in Figure 5.

In Figure 5 purple dots represent at-risk students. They are progressing in their training, but at a slower pace than the orange and green students. Their average

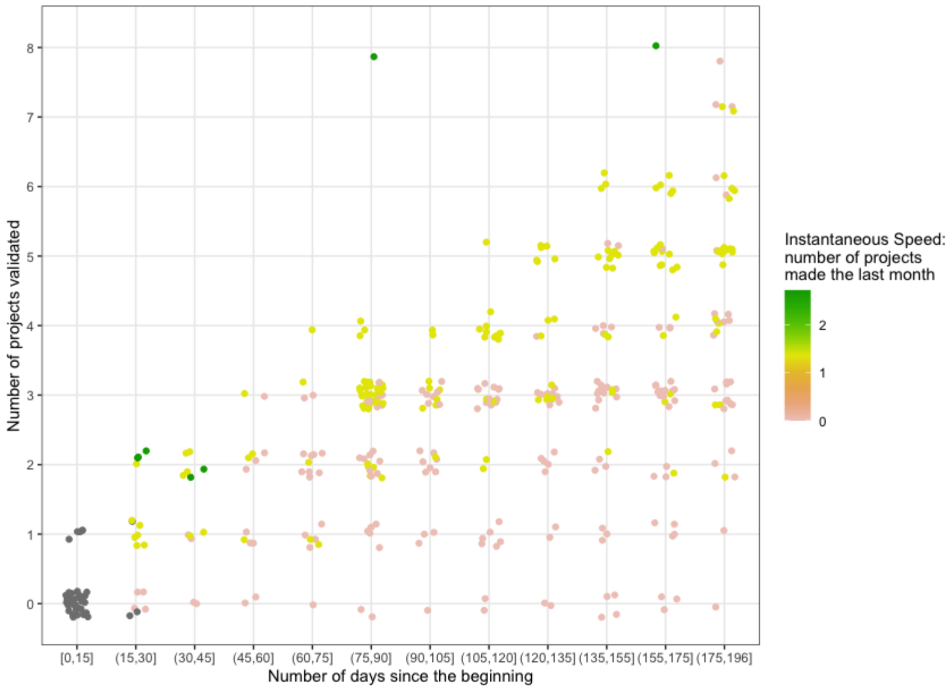

Figure 4: Distribution of students according to their achievement, the number of days in the training, and their instantaneous speeds

speed is approximately half a project per month. The flow of these students is mainly directed towards the east, while the orange and green flows are directed towards both the north and the east.

By using three datasets, we can calculate the instantaneous acceleration of the students. With a fourth dataset, we can calculate both the average acceleration and an indicator of regularity or consistency to estimate the reliability of the speed. This will enable us to determine whether a student's speed and acceleration remain consistent across all extractions.

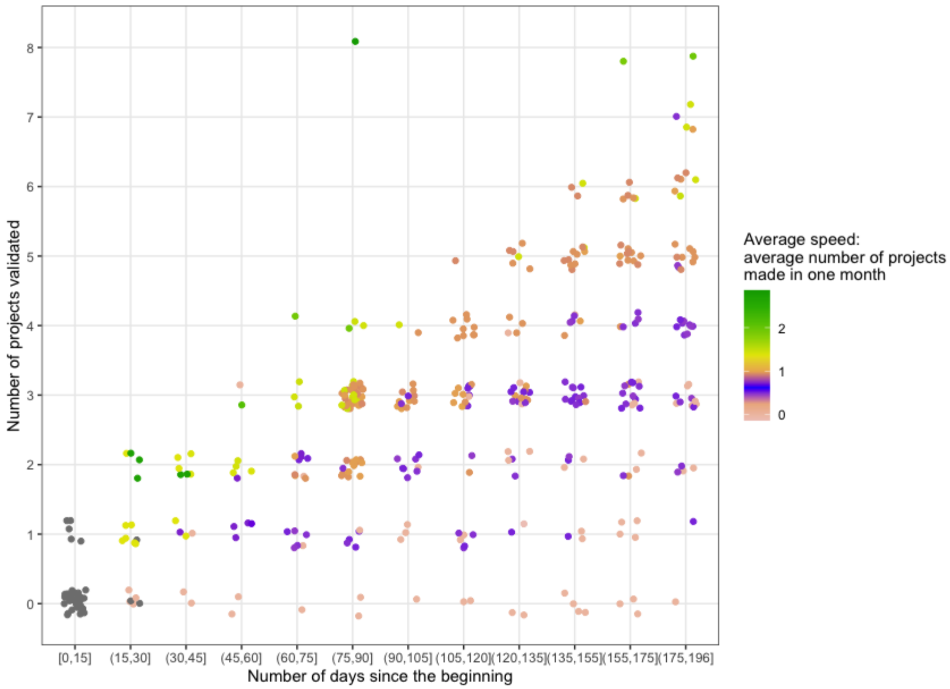

Figure 5: Distribution of students according to their achievement, the number of days in the training, and their average speed

4 Conclusion

This study is still in its early stages and is ongoing. It shows that by using two variables (starting time and number of projects completed) from at least two datasets extracted at different moments during training, we can visualize the streams of students. By calculating instantaneous and average speed, we can identify students who need special or extra attention from course educators.

Our visualization of student streams and course dynamics permits the characterization of student activity without demographic or learning predictors. By not using those predictors to define at-risk students, we can use them as explanatory variables. This method avoids the issues of defining dropout, as shown by [7].

Calculating the speed of students enables the representation of streams. If the results from [11] apply to our context, we can predict the dropout of at-risk students by identifying a deceleration in the students' training.

The checkerboard graph can be summarized with a tree, which will provide an easy way to create typologies and construct profiles.

Our next step is to calculate acceleration and regularity indicators based on four extractions. These indicators will show other aspects of the streams, such as whether borderline students are regular or if their pathways are irregular. Then, we will seek correlations with logistic regression. Finally, we will attempt to predict the behavior of at-risk students using the Random Forest and Gradient Boosting algorithms.

Two predictors will be used to do so: factors that are the responsibility of the training designers and those that are the responsibility of the learners. Once this distinction is established, we will be in a position to answer common research questions on dropout by identifying predictors based on students' navigation through the course concerning its design and the potential to act on them.

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Descriptors and EU Standards to Support the Recognition of MOOCs

Ada Giannatelli and Alessandra Tomasini

Politecnico di Milano – METID
Piazza Leonardo da Vinci, 32 – Milano

Digital technologies have enabled a variety of learning offers that opened new challenges in terms of recognition of formal, informal and non-formal learning, such as MOOCs.

This paper focuses on how providing relevant data to describe a MOOC is conducive to increase the transparency of information and, ultimately, the flexibility of European higher education.

The EU-funded project ECCOE took up these challenges and developed a solution by identifying the most relevant descriptors of a learning opportunity with a view to supporting a European system for micro-credentials. Descriptors indicate the specific properties of a learning opportunity according to European standards. They can provide a recognition framework also for small volumes of learning (micro-credentials) to support the integration of non-formal learning (MOOCs) into formal learning (e.g. institutional university courses) and to tackle skills shortage, upskilling and reskilling by acquiring relevant competencies. The focus on learning outcomes can facilitate the recognition of skills and competences of students and enhance both virtual and physical mobility and employability.

This paper presents two contexts where ECCOE descriptors have been adopted: the Politecnico di Milano MOOC platform (Polimi Open Knowledge – POK), which is using these descriptors as the standard information to document the features of its learning opportunities, and the EU-funded Uforest project on urban forestry, which developed a blended training program for students of partner universities whose MOOCs used the ECCOE descriptors.

Practice with ECCOE descriptors shows how they can be used not only to detail MOOC features, but also as a compass to design the learning offer. In addition, some rules of thumb can be derived and applied when using specific descriptors.

1 Introduction

The online delivery of Higher Education (HE) was accelerated first by the emergence of open learning, and then by COVID-19 pandemic. As the digital transformation of HE gathers momentum, MOOCs cater for the needs of an increasingly diversified student population and open up opportunities to develop new competencies demanded by the labour market. MOOCs can be integrated into formal learning paths and can support transnational mobility (whether physical, virtual or a combination of the two) in both higher education and lifelong learning, but challenges arise in terms of recognition of learning.

Upon successful completion, a MOOC can issue a credential, which is, in its most essential form, a documented statement containing claims made about a person, such as a diploma or a certificate.

The recognition of MOOCs enables learners to transition from non-formal to formal education; a further advantage is that a credential can also count toward earning a further credential (stackability). Recognition has two meanings: the process of issuing a certificate, diploma or title which has formal value even if the learning has taken place non formally (credentialisation); the process of formally accepting a certificate, a diploma or title issued by a third party institution, which attests that a set of learning outcomes achieved by an individual has been assessed by a competent body against a predefined standard. A report from the EU Joint Research Centre (JRC) (2019) presents practical guidelines for the implementation of open education practices in HE and highlights the increasing importance of the recognition process [3].

Despite the fact that European Higher Education Institutions (HEIs) use the same reference standards and currency, i.e. ECTS credits, the recognition of sub-degree credentials earned online is still not common practice because there are no widely established practices to this end and HEIs are reluctant to trust the reputation of credential issuers they are not familiar with [5].

Making learning explicit through the codification of knowledge, skills and competences in qualifications is conducive to streamline recognition through an increased transparency of information. This is instrumental to foster the flexibility of European HE and to keep at pace with the constantly evolving needs of the labour market by documenting the achievement of the most sought-after skills.

In this context, the paper presents the synergy between two EU-funded projects:

- ECCOE project[1](2019–2022), which identified the most relevant descriptors with a view to supporting a European system for micro-credentials; the MOOC

[1]Available at https://eccoe.eu/

platform of Politecnico di Milano (POK) adopted these descriptors to present the information about its learning opportunities;

- Uforest project (2020–2023) on urban forestry[2], which developed a MOOC-based blended training program for students from partner universities and took up the ECCOE descriptors as a compass to design the learning offer and to streamline recognition of learning.

2 Describing Learning Opportunities

The EU-funded ECCOE project developed a system of tools to support the digitalisation and recognition of credentials by increasing trust in technology-enabled credentials among students, HEIs and employers and in particular:

- a comprehensive list (dataset) of credential descriptors, reviewed through extensive internal and external processes of feedback; the methodology is described in a specific paper [2];
- the learning opportunities catalogue, which provides examples of how to describe a learning opportunity[3].

If an organization issues a micro-credential for a MOOC and wants this credential to be easily recognizable by other HEIs, it is paramount to properly describe it, with the focus being set on the learning outcomes and resulting competencies. That is true especially if the credential is presented for recognition without any existing agreement between the issuing institution and the receiving institution.

Descriptors indicate the specific properties of a learning opportunity according to European standards: they can provide a recognition framework also for small volumes of learning (micro-credentials) to support the integration of non-formal learning (MOOCs) into formal learning (e.g. institutional university courses), to enhance both virtual and physical mobility and to tackle skills shortage, upskilling and reskilling by acquiring relevant competencies. Micro-credentials certify the learning outcomes of educational experiences that are shorter than traditional qualifications, for example a MOOC.

A micro-credential potentially ranges from a minimum of one ECTS credit with an upper limit of less than a full degree.

[2] Available at https://www.uforest.eu/

[3] Available at https://eccoe.eu/wp-content/uploads/sites/28/2022/09/ECCOE_O3_Learning-Opportunities-Catalogue_Public-Report.pdf

2.1 European standards

Micro-credentials cannot reach their full potential without common standards ensuring their quality, transparency, cross-border comparability, recognition and portability. The EU has developed the European Learning Model (ELM) to capture the results of any non-formal, informal and formal learning across Europe. It is designed to provide a single format to describe any kind of claims that are related to learning, from certificates of attendance, to degrees to diploma supplements. ECCOE credential descriptors, and the dataset of credential qualities, can complement the ELM database of descriptors: ECCOE partners first defined the main required descriptors with reference to the European Digital Credential Infrastructure (EDCI) data model for learning opportunities.

European Digital Credentials for Learning – EDC are a recently launched EU standard for issuing education credentials (e.g. diplomas, transcripts of records, etc.). In late 2022 a new version of the EDC infrastructure was released, which allows for issuing credentials potentially in 29 languages (multilingualism), and ELM v3 is being progressively released in 2023. As part of the ECCOE sustainability plan, experiments are being carried out to issue digital credentials through the EDC infrastructure such as in the case of the upcoming MOOC of the FemPower project[4]. For more in-depth information about issuing digital credentials, ECCOE developed the How-to guides [1].

EDCI can be potentially integrated into the online student services and MOOC delivery platforms of a university: in case two HEIs have integrated their respective student management systems with EDCI, a fully automated mutual recognition of credentials is possible. However, whether a HEI integrated the EDCI standards or not is only a small part of the question: technical interoperability only accelerates and simplifies the recognition procedure, it does not replace it. To solve this problem and support credential issuing institutions in automating the process, the ECCOE project developed a template for a Model Credit Recognition Agreement – MCRA [6], that can be used by those HEIs wishing to establish mutual agreements to recognise and validate each other courses.

Another key element within the European standard ecosystem for credentials is the reference to ESCO, which is the classification of European Skills, Competences, Qualifications and Occupations: in particular the ESCO skills and knowledge hierarchy[5] is a single all-embracing hierarchical framework containing four distinct sub-classifications:

[4] Available at https://www.pok.polimi.it/courses?search_query=CET101
[5] Available at https://esco.ec.europa.eu/en/classification/skill_main

- Knowledge
- Language skills and knowledge
- Skills
- Transversal skills and competences

The Learning Outcome of a MOOC can be linked to the appropriate ESCO skill(s) by using the respective URI(s), that is Unique Resource Identifier, a persistent and machine-readable string of characters, which identifies each ESCO skill (see an example in the table). It also points to suitable translations, as ESCO is multilingual. It is important to use verbs that indicate what the learner will be able to do by achieving a Learning Outcome.

To describe a MOOC its provider can search for a suitable match with each Learning Outcome of the MOOC by scrolling through the structure of the taxonomy and/or with a keywords search: it is worth noting that the new version of ESCO (1.1) improved the mapping of digital, green, transversal skills and skills for researchers. ESCO is aligned with DigComp framework, whose updated version DigComp 2.2 [7] provides new examples of knowledge, skills and attitudes and takes into account emerging technologies such as Artificial Intelligence, the Internet of Things and datafication or new phenomena such as the new teleworking conditions. The ESCO skills hierarchy, updated in early 2022, is in a continuous process of improvement.

Another aspect that needs to be pointed out is that ESCO skills and knowledge hierarchy can act as a lever for fine-tuning the learning outcomes of courses irrespective of their volume of learning, from whole study programs (such as bachelor's or master's degrees) to short courses and learning paths such as MOOCs.

3 Uforest case study and anatomy of descriptors

The Uforest project developed a training program to support students and practitioners in the implementation of innovative Urban Forestry projects and help them maximize the economic, environmental, and social benefits of nature-based solutions. It has been conceived as a blended path (Figure 1) made of an initial MOOC-based part, hosted on Polimi Open Knowledge (POK) platform, and a second in-person part, as intensive 14-days training for students of partner universities.

Figure 1: Uforest training innovation program

When partner universities (Politecnico di Milano, Transilvania University of Brasov, Trinity College Dublin, Universitat Autònoma de Barcelona) started the design process, they explored how they could offer ECTS credits recognition to learners from outside their respective HEIs. During this investigation process, it was decided to use the ECCOE descriptors to design the online learning opportunity. The aim was to ensure that it is aligned with micro-credential standards, if the Uforest universities should decide to create them.

Interestingly enough, the co-design process of the learning outcomes that learners are expected to achieve at the end of the Program was very challenging for partners. A survey was administered to university students, professionals and citizens from different Countries to identify training needs in the areas of innovation and entrepreneurship in urban forestry and Nature Based Solutions (NBS) [4]: its results in terms of demanded knowledge and skills fed into learning outcomes.

Currently just one university, the Trinity College Dublin, has moved in this direction by activating the micro-credential "Entrepreneurship for the Nature-based Enterprise", available upon selection to anyone interested, not only to its enrolled students[6]. At the time of writing, around 25 % of students of the micro-credential are coming from outside Trinity. This process has evolved according to internal rules of each university. The fact that the use of ECCOE descriptors has been agreed from the outset of the Uforest project has allowed the smooth integration of Trinity's new academic provision into the Uforest learning opportunity.

Table 1 shows some examples of how ECCOE descriptors have been applied to one of the Uforest MOOCs.

[6]Available at https://www.tcd.ie/courses/microcredentials/by-school/micro-credentials---business/entrepreneurship-for-the-nature-based-enterprise---micro-credential/)

Table 1: Descriptors

Criterion / Label	Definition	Descriptors in Uforest
Title	Title of Learning Opportunity	Nature in the city: turning knowledge into urban forestry practice
Description	A summary of the learning opportunity	This course focuses on introducing the concept of Urban Forestry (UF), exploring the different and closely interrelated topics that constitute the foundations of this field. The course is designed as a choral MOOC based on the valuable experiences of international experts. Real case studies offer a compelling picture of challenges and strengths that needs to be considered when designing a new initiative on Urban Forestry.
Learning Opportunity Type	e.g. course, module, MOOC (suggested standard vocabulary)	MOOC
Provided by	e.g. the institution responsible for offering the MOOC	Politecnico di Milano in collaboration with Ente Regionale per i Servizi all'Agricoltura e alle Foreste (ERSAF), Etifor | Valuing Nature, The European Forest Institute (EFI), The Universitat Autònoma de Barcelona (UAB), CREAF, AGRESTA Forest solution for the future, Transilvania University of Brașov (UNITBV), Forest Design, Trinity College Dublin, Nature Based Solutions Institute, Green City Watch
Hosted by	The name of the platform hosting a learning opportunity	Polimi Open Knowledge platform
Type of provider	e.g. HEI, Private business school etc.	HEI
Provided at	The location (physical and/or virtual) where the learning opportunity will take place	Polimi Open Knowledge platform www.pok.polimi.it
Language(s) of Instruction	e.g. English	English
Start Date / End Date	The date from which a person may follow the learning opportunity, or "any start date"	Classes Start Nov 21, 2022 Classes End May 21, 2023

Duration	The duration for which the learning opportunity will continue to run	expressed in months (in whole number) e.g. six months
Learning Schedule	Timetable	The course is structured in seven Weeks: Week 0 – Introduction to the course Week 1 – History of urban forestry Week 2 – Urban Forestry planning and design Week 3 – Urban forest ecology Week 4 – Socioeconomics – Governance and community engagement Week 5 – Entrepreneurship and innovation Week 6 – Final assessment Week 7 – Live events – Urban Forest Case Studies
Workload in Hours	The estimated number of hours the learner should spend to earn the award	50
Admissions Procedure	Specific information on how to apply for the course	You can access the course fully online. Course materials will remain available to all enrolled users after the end of the current edition, so they can return to content later. The current course edition will be followed by a new one just after its end.
Entry Requirements	The criteria the person should meet to start this learning opportunity	No prerequisite knowledge is required for this course.
Fees	Information about the pricing of the course	You can access the course entirely free of charge.
Mode of learning	online, blended etc.	Online
ECTS Credit Points	If the MOOC awards ECTS and, if it does, number of ECTS credits for the MOOC	The Certificate of Accomplishment in itself does not confer any academic credit, grade or degree, but learners who successfully complete passes this MOOC and the advanced online course of Uforest program titled “Greening your city: develop your urban forestry project” within the Uforest program, can be entitled to achieve 6 ECTS issues by Uforest partner universities.

Type of credential	A badge, a certificate of attendance, a paper diploma, a digital credential etc.	The Certificate of Accomplishment will be issued to anyone who successfully completed the course by achieving at least 60 % of the total score in the assessed quizzes. You will be able to download the Certificate of Accomplishment directly on the website.
Discipline / subject area (Thematic Area)	According to ISCED-F classification	0731 Architecture and town planning 0821 Forestry 0413 Management and administration 0521 Environmental sciences 0522 Natural environments and wildlife 0712 Environmental protection technology
European Qualifications Framework (EQF)	Level expressed in terms of EQF	Level 7
National QualificationeFramework Level		–
Description of learning outcomes	Description in terms of learning outcomes	By completing this course you will be able to:
Related ESCO Skill(s)	For each Learning Outcome, direct reference to the specific ESCO skill(s)	• explain and discuss the concept of urban forestry and its key characteristics and provide a broad yet comprehensive overview of key concepts in smart and sustainable city planning (ESCO – specialize in an area of history; ESCO – urban planning; ESCO – develop forestry strategies) • identify urban and peri-urban forestry categories and the main UPF design principles (ESCO – manage landscape design projectsESCO – urban planning;) • recognise ecosystem services provided by urban forests, differentiate between different ES (ESCO – sustainable forest management; ESCO – forest ecology)

		• understand the basic concepts of forest ecology and management, of a tree inventory, forest monitoring and how existing areas can be included in developing plans (ESCO – forest ecology; ESCO – analysing and evaluating information and data; ESCO – apply digital mapping; ESCO – manage forests) • recognize the complex nature of urban forest governance, the roles of different actors and stakeholders and how to engage them to be participative (ESCO – sustainable forest management; ESCO – engage with stakeholders; ESCO – work within communities) • understand and explain the concept and practice of entrepreneurship in urban forestry, relevant impact indicators and the dynamics underlying the formation and growth of entrepreneurial ventures (ESCO – show entrepreneurial spirit) • identify a range of different public and private ways to fund urban forestry initiatives and how to make them attractive for investment / grants (ESCO – Funding methods)
Activities	Activities which a person can perform to acquire the expected learning outcomes	Throughout the MOOC, over and above consulting the content, in the form of videos, additional web-based resources and webinars, you will, through the forum or other digital tools that support sharing and comparing ideas, work on reflecting on the contents and experiences brought by the MOOC experts and improving your own experience taking into consideration the inputs emerged from discussions with peers. To obtain the certificate, you should complete the whole MOOC, read the additional resources and reply to Weekly and Final quizzes. We strongly encourage you to take part in the activities and discussions that you find most useful and relevant for your own professional development. These activities guide you in:

		• focusing or reflecting on specific inputs individually; • interacting with the other learners during webinars and through external tool, like Padlet and Answer Garden; • sharing and discussing experiences, challenges, and solutions with the aim to help and support professional development.
Assessments	Assessments a person can undergo to prove the acquisition of the learning outcomes	The final grade for the course is based on your responses to the quizzes you will find at the end of each week (weekly quizzes), to the final quiz (Week 6), and to the two quizzes linked to case studies discussed during live events (in Week 7). Remember that questions refer to video lessons, live events, and additional resources. Questions are proposed randomly from a bulk. Scoring for the quizzes equals 1 point per question. Remember, the system will record the result of your final attempt, not the best of your attempts. The course is considered successfully completed if the participant reaches 60 % of the total score. Therefore, we strongly encourage you to take part in the activities and discussions. The course's total score will be calculated by summing the scores of all the assessed quizzes: weekly quizzes, final quiz, and live event's quizzes.

3.1 Practical takeaways from practice with descriptors

Adopting ECCOE descriptors in a variety of learning opportunities allowed to derive some rules of thumb that can be applied in using specific descriptors:

- **Related ESCO skills** – not any skill can be referenced to ESCO, but wherever possible it is recommended to associate 1 to 3 relevant ESCO skills to each Learning Outcome; in case of multidisciplinary learning outcomes, more than one ESCO skill can give an account of the multidisciplinary dimension. Operationally it means to add to the Learning Outcome a direct reference to the specific ESCO skill using the ESCO unique identifiers, that is the ESCO skill expressed in natural language + its URI (Uniform Resource Identifier). Mapping learning outcomes against ESCO taxonomy allows for cross-border comparability.

- **EQF level** – it is indicative and is defined on the basis of the EQF level description that matches all or at least the majority of MOOC learning outcomes[7]. For general guidance: a MOOC corresponding to a face-to-face curricular BSc or MSc module in the same HEI generally equals EQF level 6 and EQF level 7 respectively, but this hint needs to be verified in each case. It is worth noting that a MOOC can be described as corresponding to a EQF level (e.g. EQF level 5) but can be used/instantiated as a part / module of a program which has a different EQF level (e.g. EQF level 6). In addition to the European framework, a learning opportunity can be mapped against a National Qualification Framework as well, if relevant/applicable.

- **Discipline / subject area** – is defined according to ISCED-F taxonomy and the MOOC provider should choose the most appropriate level of detail among the three available in ISCED-F[8]:

  Level 1 – broad fields (two figures): e.g. 05 Natural Sciences, Mathematics and Statistics

  Level 2 – narrow fields: (three figures): e.g. 051 Biological and related sciences

  Level 3 – detailed fields (four figures): e.g. 0512 Biochemistry.

  If relevant, more than one ISCED-F field can be assigned to a single learning opportunity, e.g. in the case of multidisciplinary courses.

- **Workload in Hours** – as the ECTS credits are the currency within the European higher education, whenever possible it is advisable to design the MOOC so that its workload equals the number of hours required for 1 ECTS credit or multiples thereof in the Country of the issuing institution (e.g. 25 hours workload for one ECTS credit in Italy).

4 Conclusion

The existence of a political will in HEIs is crucial to accelerate and simplify the ECTS recognition procedure. In this direction, the comprehensive dataset of credential descriptors, tested, reviewed and implemented in ECCOE provides a sound basis for making the academic recognition process as agile as possible. The calibration with ELM-controlled vocabularies also supports the list of credential descriptors.

[7]Available at https://ec.europa.eu/ploteus/en/content/descriptors-page https://europa.eu/europass/en/description-eight-eqf-levels

[8]Available at https://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-fields-of-education-and-training-2013-detailed-field-descriptions-2015-en.pdf

Properly describing a credential paves the way to unleash the potential of micro-credentials for university students' mobility, be that physical, virtual / online) (as in Uforest), or a combination of the two; it also creates visibility for a particular learning offer, opens up learning pathways, and provides flexible training opportunities for people with more disadvantaged socioeconomic status. Ultimately, providing relevant data to describe a MOOC is conducive to the flexibility of European higher education by increasing the transparency of information. The use of Learning Outcome descriptors referenced to ESCO works in the same direction and fosters transnational and virtual mobility by supporting cross-border interoperability of information and comparability of skills.

In the cases of Uforest project, detailing learning outcomes and resulting competences acted as an innovation lever at an early stage of design of the blended training program. In addition to that, it will facilitate partner universities to offer the Uforest training program or part of it (e.g. the MOOC) as a micro-credential.

The ability to calibrate learning outcomes to ESCO skills and competencies, and therefore the possibility to indicate them in the certificate in the future, makes them more relatable for the labour market.

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A Metastandard for the International Exchange of MOOCs

The MOOChub as First Prototype

Thomas Staubitz[1], Sebastian Serth[1], Max Thomas[1], Martin Ebner[2], Markus Koschutnig-Ebner[2], Florian Rampelt[3], Alexander von Stetten[4], and Andreas Wittke[5]

[1] Hasso Plattner Institute, University of Potsdam
Prof.-Dr.-Helmert-Str. 2–3, 14482 Potsdam, Germany
[2] Graz University of Technology
Münzgrabenstraße 36/I, 8010 Graz, Austria
[3] Stifterverband
Tempelhofer Ufer 11, 10963 Berlin, Germany
[4] Virtuelle Hochschule Bayern
Luitpoldstr. 5, 96052 Bamberg, Germany
[5] Technische Hochschule Lübeck
Mönkhofer Weg 239, 23562 Lübeck, Germany

The MOOChub is a joined web-based catalog of all relevant German and Austrian MOOC platforms that lists well over 750 Massive Open Online Courses (MOOCs). Automatically building such a catalog requires that all partners describe and publicly offer the metadata of their courses in the same way. The paper at hand presents the genesis of the idea to establish a common metadata standard and the story of its subsequent development. The result of this effort is, first, an open-licensed de-facto-standard, which is based on existing commonly used standards and second, a first prototypical platform that is using this standard: the MOOChub, which lists all courses of the involved partners. This catalog is searchable and provides a more comprehensive overview of basically all MOOCs that are offered by German and Austrian MOOC platforms. Finally, the upcoming developments to further optimize the catalog and the metadata standard are reported.

1 The MOOChub

The MOOChub provides a centralized, searchable catalog of all courses on German and Austrian MOOC platforms. The dedicated goal of the MOOChub is to provide learners with a cross-platform overview of all available course offerings and enable them to find suitable courses for their learning needs, regardless of the MOOC provider.

The genesis of the MOOChub goes back to two almost parallel activities. In 2015, in discussions between the TH Lübeck (MOOC platform oncampus, formerly mooin) and the TU Graz (MOOC platform iMooX) the idea emerged to mutually list each other's MOOCs. Both platforms were dedicated to Open Educational Resources (OER) and free accessibility of online courses, so they saw a good opportunity to increase mutual awareness by listing each other's offerings on their websites. They also experimented to offer an online course simultaneously on both platforms [10, 11]. In parallel, the Hasso Plattner Institute's MOOC platform openHPI and SAP's MOOC platform openSAP set up a project named mammooc to combine the growing range of courses on an increasing number of world-wide MOOC platforms. Their vision was to offer learners a one-stop shop to search for new learning opportunities and centrally manage their course enrollments across various MOOC providers. In addition to courses from openHPI and openSAP as the directly involved platforms, MOOCs from other providers (such as Coursera, edX, or FutureLearn) were also included in the mammooc course catalog via proprietary interfaces. Finally, in cooperation with the TH Lübeck, the provider-independent exchange format for course metadata, which was initially developed as part of the mammooc project, premiered in early 2017.

Based on these preliminary projects and considerations, all major German-language MOOC platform operators first met in 2020 to discuss options for a centralized platform catalog. In a regular exchange, they discussed how learners could be provided with a common, cross-platform offering. This endeavor was not entirely trivial for several reasons: the platforms have different operators and operating models, different target groups, different course topics and, above all, different technical infrastructures. Therefore, the most important objective was to create a common understanding and define possible goals of joint activities. As a result, the founding members – namely the TH Lübeck (platform mooin/oncampus), the Hasso Plattner Institute (platform openHPI), the Stifterverband (platform KI-Campus), the Virtual University of Bavaria (platform OPEN vhb) and the TU Graz (platform iMooX) – agreed to operate an aggregator platform on which the free, open online course offerings of all partners are listed. Gradually, this aggregator was put into practice and is now operated under the name MOOChub. The TU Graz agreed to cover the technical part of the MOOChub platform development and operation. The Hasso Plattner Institute agreed to take the lead in the further development of the metadata format.

The guiding principles for the MOOChub include:

- Joint regular exchange and cooperation to strengthen education
- Openness of educational offers

- Interoperability, based on the Groningen Declaration[6]
- High quality offerings
- Supporting lifelong learning
- Achieving Bologna Process goals through digital technologies

The following objectives were derived from this:

- Making educational offerings visible by providing an overview of all available online courses (the various MOOC offerings) of the partners
- Common authentication of learners across platforms
- Exchange on standards and frameworks to support the recognition and crediting of digital educational offerings in higher education and vocational fields
- Creation of technical standards, both at the level of the platforms and their interfaces with each other
- Creation of standardized processes and workflows
- Common quality standards for digital education offerings
- Pooling of resources and thus creation of a sustainable educational offers

At the current state, the first of these objectives has already been successfully implemented in the form of the common course catalog with the MOOChub platform. For this purpose, it was necessary to develop a common course catalog metadata format for the description of the online courses. In this publication, we want to present this course catalog format as well as its development and application. Finally, we discuss the experiences so far and point out possible further steps.

In addition to the MOOChub and the associated MOOC platforms using the course catalog format for the data exchange, other providers as well as aggregators were invited and encouraged to use and contribute to this format. In addition to the founding members previously mentioned, the course offerings of the openSAP, LERNEN.cloud and eGov-Campus platforms, which are also free and openly accessible, were added to the MOOChub catalog. On the aggregator side, the Open Educational Resources Search Index (OERSI)[7] and the Kompetenznavigator Schleswig-Holstein[8] use the course catalog metadata format to list courses

[6] https://www.groningendeclaration.org/
[7] https://oersi.org
[8] https://www.findig.sh/

from the various MOOC platforms in their catalogs. OERSI is operated by the library of Leibniz University Hannover and the university library center of North Rhine-Westphalia, Germany. The "Kompetenznavigator" is a project of the Administration Laboratory at the "Zentrale Einrichtung für Angewandte Forschung" (ZEAF) of the University of Applied Sciences for Administration and Service in Schleswig-Holstein, Germany. Further discussions with other providers and aggregators are held on a regular basis and we are always open for an exchange with interested parties. Most recently, the format has also been approved as one of the metadata exchange formats that will be used by the new "Nationale Bildungsplattform" (NBP), a project funded by the German Ministry of Education, MERLOT, a project funded by the German Ministry of Economics, and Digital.Campus Bayern, a project funded by the Bavarian State Government.

2 Existing metadata formats for learning resources

Before we started to develop a common course catalog format for easy delivery of course metadata for MOOC platforms, we explored which existing metadata formats for learning resources were available. The two most widely used standards so far are the IEEE Standard for Learning Object Metadata [16], which is also part of the Sharable Content Object Reference Model [25, 22], and the more modern community-based approach of schema.org[9]. Both standards, however, prove not to be completely suitable for describing online courses and the specific characteristics. In addition to analyzing the standards, we compared how the partners and other established MOOC platforms provide metadata for their courses and which standards they used. It became apparent early-on that although there was no suitable standardized approach so far, there was a great deal of interest among the platforms to collaborate and establish a standardized exchange format.

Early research on a MOOC aggregator identified the difficulties in this regard as early as 2015 and showed the range – from Linked Data to processing the rendered web page – in collecting necessary data [17]. According to the researchers, a proprietary interface for retrieving the course catalogs was only available at a later point in time across all major MOOC platforms [6]. The multitude of different standards and formats in the learning context (and their specific advantages and disadvantages) has been the subject of research even before the increased popularity of MOOCs [19]. To some extent, there are also attempts to establish standards in related areas (e. g. for micro-credentials at the European level; [2]). Sometimes, in-

[9]https://schema.org/

ternational standards such as LOM are adapted for specific use cases, for example by the "Kompetenzzentrum für interoperable Metadaten" (KIM, [3, 21]).

Particularly relevant for the further use of learning materials described by the corresponding metadata, is often their free availability as Open Educational Resources (OER). Projects such as MERLOT[10] therefore have been collecting free educational resources for over 20 years and have been describing the relevance of equally free interfaces for retrieving the metadata [24]. In this context, the support of standards by content providers is considered a prerequisite for building a comprehensive collection of learning materials [5]. As illustrated by the OpenupEd platform, this can also help to counterbalance the leading, mostly U.S.-based content providers at the European level [13]. In addition to the OpenupEd platform (operated by the European Association of Distance Teaching Universities [7]), there were further efforts between 2016 and 2019 with EMMA as European Multiple MOOC Aggregator [1] to collect courses from the European context and offer them simultaneously in multiple languages.

Besides those initiatives focusing on European offerings, other platforms without such a focus were created, listing as many courses from various providers as possible. These usually include advertisements or commercial offers to the listed platforms. When learners enroll in a paid course by clicking on one of the affiliated links shown by the MOOC aggregators, MOOC platforms pay a commission to the respective aggregator. Examples of MOOC aggregators financed by affiliate links and advertisements include Class Central[11], Coursesity[12], and MOOC-list[13]. Therefore, these providers can allocate more resources in developing and maintaining their platform, including an adaption to more formats. With the MOOChub, we envision an ad-free catalogue of OER resources, inviting partners to join our efforts by providing data in an open schema.

3 Collaborative development of a common course catalog format

The development of the MOOChub schema required intensive discussions with all partners and is based on the experiences from the mammooc project [23]. The metadata format[14] developed in this project formed the conversational foundation for

[10] https://merlot.org/merlot/
[11] https://www.classcentral.com/
[12] https://coursesity.com/mooc
[13] https://www.mooc-list.com/
[14] https://github.com/MOOChub/schema

defining the current MOOChub schema for data exchange. Further development involved identifying the existing similarities between the course offerings, working out trade-offs for differences, and considering new developments in the MOOC context. Given the differences between offerings of the involved MOOC providers, the format was defined to include a basic set of mandatory fields on one hand and a set of optional fields on the other. This allows adapting the format to the specific use cases of each MOOC provider. At the same time, though, the format allows for a largely homogeneous presentation of the courses from all providers on the MOOChub website as well as by other aggregators.

The selection and naming of the fields in the MOOChub schema are based on the preliminary work performed by the mammooc project and the existing "Course" standard of schema.org[15]. However, minor changes were made to adapt to the special circumstances of MOOCs, for example by allowing to specify several dates for the course start, deadlines, or availability. Schema.org was introduced in 2011 by Google, Microsoft, Yahoo, and Yandex to create a uniform vocabulary to be used on the web [14]. Further development of the standard is done in an open process with the community. Based on the preliminary work, it was agreed to use the schema.org format as the basis for the MOOChub schema. Given that the MOOChub schema only extends schema.org and as long as these extensions are optional, compatibility with the original standard is guaranteed. The use of such a widely accepted basis facilitated the agreement process among stakeholders immensely. Another advantage of using schema.org as a basis is that this also has a positive impact on search engine rankings. Providers who are only compatible to the original schema.org standard can thus use at least the basic functionality of the MOOChub schema. However, additional features that require special data from the optional fields may be reserved for providers that support the full format.

In theory, as it is often the case, the practical implementation diverged at some point from the theoretical foundation. During the ongoing development and further distribution of the MOOChub schema, elements were included in the implementation that are no longer compatible with schema.org. For this reason, a revision of the format is currently being prepared to restore compatibility with schema.org.

In addition to the technical aspect, it should be mentioned that the chosen "grassroots approach" has proven to be very successful in the implementation so far. The steadily growing number of partners using the course catalog format, both on the MOOC platform side and on the aggregator side, immensely strengthens the argumentation standpoint towards new potential partners. The existing and demonstrably well-functioning format is often gratefully accepted.

[15] https://schema.org/Course

4 Course catalog format description

The exchange of metadata for the courses is based on the JavaScript Object Notation (JSON). The MOOC providers make this data available via an Application Programming Interface (API). In this regard, both the use of an API and the JSON format are in line with the current industry standard for metadata exchange. In the JSON format, fields are defined as key-value pairs and nested objects. Here, each key corresponds to a unique, predefined identifier. Depending on the definition, specifying values in accordance with the respective data type is mandatory or can be voluntary. Figure 1 shows an excerpt from the JSON format.

```
        ]
      },
      "instructors": [
        {
          "name": "Prof. Dr. Christoph Meinel"
        }
      ],
      "learningObjectives": [],
      "duration": "P2M4D",
      "partnerInstitutes": [],
      "moocProvider": {
        "name": "openHPI",
        "url": "https://open.hpi.de/",
```

Figure 1: Excerpt from a JSON file with course data according to the MOOChub schema

4.1 Required fields

The use of the MOOChub schema requires participating MOOC providers to provide a mandatory set of metadata for each course. This set includes:

- “name”: the course title. It is stored in the form of a string and is mostly used as a heading in the catalog display.

- “courseMode”: the course type. The course type is specified in the form of a string. Currently, “MOOC” is the only valid value. With an upcoming revision of the MOOChub schema, the list of allowed values will be extended in the future.
- “instructors”: the instructor(s). This is a list of the complex data type “instructor”. This data type was defined specifically for the MOOChub schema and is therefore not compatible with the original standard. We will deal with this and other necessary changes in the chapter “Discussion and Outlook”.
- “moocProvider”: the provider of the course. This is also a separate complex data type.
- “url”: the URL to the course content. A string in the form of a valid Internationalized Resource Identifier (IRI according to RFC3987, [8]) is stored here.
- “courseLicenses”: the course licenses. The specification is made as an array of the complex, own data type “courseLicense”. By using multiple licenses, different usage scenarios of MOOC providers including multi-licensing are covered.
- “access”: the access modifier. In an array of strings, the modifiers “free”, “paid”, “member-only” and “other” can be specified. This field indicates whether the course is available with or without fee, or if it is only offered to a certain group of participants (such as students enrolled at a university).

This minimum data set is intended to ensure that courses can be represented consistently in the MOOChub catalog. Other aggregators and search services can also rely on the delivery of this data.

4.2 Optional fields

In addition to the mandatory fields that have been listed in the previous chapter, an additional set of metadata can be provided optionally. These fields include, among others:

- “description”: a description of the course content. A string can be specified here to provide a more detailed description of the course. The string can include HTML tags.
- “language”: the language of the course. The language versions of the course can be stored in this array of strings. The language must be specified as an abbreviation according to BCP 47 (RFC6497, [4]).

- "workload": the estimated weekly course completion time for learners in hours. This field allows an integer value (if known) or "null" as value (if explicitly not known).

The described extensions to the course catalog format help aggregators and learners to search for courses attributes and, therefore, are also a useful addition for learners to find most suitable courses. Hence, it is advisable for MOOC providers to include as much metadata as possible – including the optional fields.

Nevertheless, providers who do not want to or cannot provide all data are not prevented from using the MOOChub schema.

4.3 Data types

For efficient processing of the data, not only the identifiers of the fields but also the data types of the passed values must be standardized. Most fields can simply contain strings. In some cases, however, special specifications must be applied. Dates, for example the start date of a course, can only be passed in a date format according to ISO 8601 (2019) or RFC 3339 [20]. The URL reference to the course homepage has to be delivered as a valid IRI. In addition, simple HTML markup [15] can be used as a markup language, for example in the human-readable description of the course content.

Some fields require complex data types that have been embedded as additional objects in the JSON format. An example of such a complex data type is the specification of the instructor(s) ("instructor"). This field is defined by the instructor's name (as a string), the instructor's type (identified as a person or organization), the instructor's role, an image if applicable (stored as a URL), and a brief description of the person or organization. The "instructors" field itself is created as an array, so that multiple instructors can be added.

4.4 Versioning and pagination

In addition to the specification of the MOOChub schema in JSON format, the API also includes a versioning agreement for the data format of the respective MOOC platform. This ensures that changes in the course catalog format can be implemented independently by the MOOC platforms and the MOOChub, and that the exchange of the metadata automatically adjusts using the compatible versions. To keep the configuration effort as low as possible and to avoid URL customization, version negotiation takes place via HTTP Content Negotiation (RFC 9110, [12]). This allows the MOOChub as a client to specify a preferred version of the course catalog format, which the MOOC platform as a server uses to respond to the request whenever possible. Using this mechanism, different MOOC platforms can (temporarily) deliver different versions, so that the synchronization efforts required to implement breaking changes to the MOOChub schema can be reduced to a minimum for all involved partners. Optionally, the end of support for a specific API version can be defined using the HTTP Sunset Header (RFC 8594, [26]).

In addition to the versioning described above, the MOOChub schema allows the course catalog to be split across multiple pages when retrieving it through the API. This allows the MOOChub to gather the courses from the individual MOOC platforms in a resource-efficient manner and process them in smaller page sizes. Therefore, we specified that an API should use the JSON API standard [18], which allows linking to subsequent pages directly in the response.

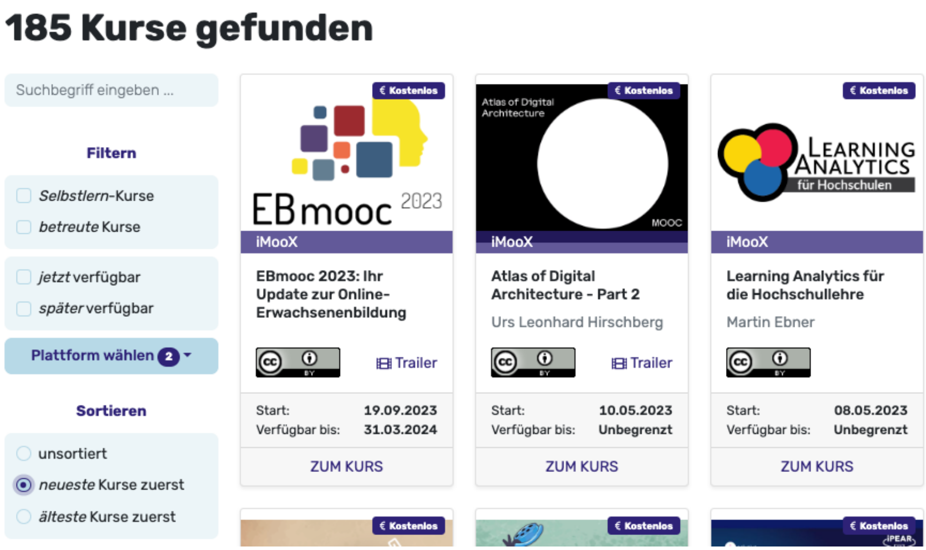

Figure 2: Filter options on the MOOChub website[16].

[16]Screenshot of the website https://moochub.org as of March 7th, 2023

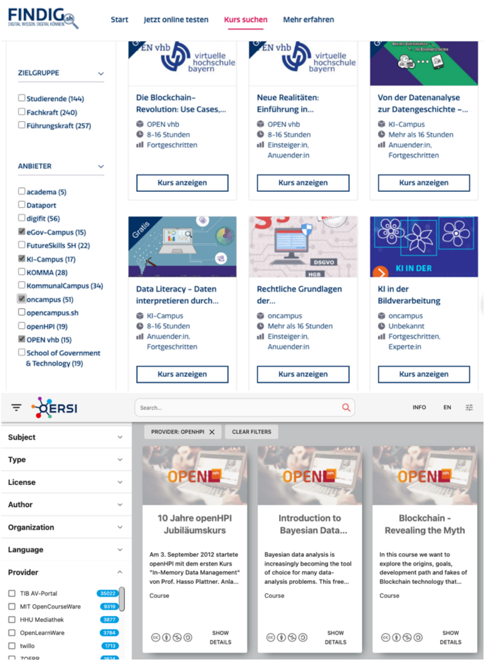

Figure 3: Further aggregators using the MOOChub metadata format[17].

5 Discussion and outlook

Once all platforms involved had agreed to cooperate with each other and jointly promote the digital education through MOOCs, the actual technical implementation presented a comparatively small hurdle. As soon as the common course catalog format was established, the self-confidence and the range of arguments vis-à-vis other platforms and aggregators increased with each new partner. The steadily growing interest is underlined by the increasing access figures.

The "grassroots approach" taken to establish this course catalog format more firmly, bit by bit, through a steadily growing user base, has been very successful. With some justification, we can now claim that the format has become a de-facto standard for MOOC platforms in the German-speaking area. In principle, there is little standing in the way of expanding the user base to include other online

[17]Screenshot of the websites https://oersi.org/ and https://www.findig.sh/ as of March 7th, 2023

course formats. For some time now, discussions have also been taking place at the European level, although there is still a comparatively large need for coordination and harmonization of the various needs. To this end, the major European MOOC providers have recently submitted a joint project application that deals with the creation of a European portal solution comparable to MOOChub. If this application is approved, the development of a European solution based on the current MOOChub schema is very likely. Additional project grants potentially leading to further standardization of the course catalog format are currently evaluated or have already been approved. Among others, the MOOChub schema was recently approved as one of the supported metadata exchange formats as part of the NBP project of the German Federal Ministry of Education and Research. There, particular attention is also being paid to how such a format can serve as a basis for recommendation services and AI-supported learning path creation. Another goal here is also to move the format from the status of a de-facto standard to the status of an official standard in collaboration with the German Institute for Standardization (DIN). Next to the NBP, the Digital Campus of the German federal state of Bavaria has also agreed to use the MOOChub schema to exchange metadata of online courses.

On the technical side, we still have to implement several necessary changes to the MOOChub schema. First, the compatibility with the original schema.org standard needs to be restored. This requires renaming some of the existing fields. While a preview of the updated schema is already available, we expect that the transition of the MOOChub and all partners will be finished by the end of 2023.

In addition to these relatively straightforward adjustments, the requirements for the MOOChub format have expanded. To integrate the courses into learning paths, further information is required, such as thematic keywords and classification of the courses into competence levels. AI-based recommendation services also need such unified course data. Smart algorithms, therefore, must be enabled to create entire learning paths for individuals based on different courses from various providers.

The MOOChub and its described standardization of the course catalog format is, therefore, a necessity to enable modern learning as well as to support learners and teachers in the best possible way in selecting or creating suitable learning opportunities.

Acknowledgment

The paper at hand is based on a paper in German language that has been published in the Austrian journal “Zeitschrift für Hochschulentwicklung” in March 2023 [9].

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Thai MOOC Academy

Extending the Platform Towards a Sandbox for the National Credit Bank System in Thailand

Anuchai Theeraroungchaisri[1,2], Thapanee Thammetar[2,3], Vorasuang Duangchinda[2,4], and Jintavee Khlaisang[1,4]

[1] Chulalongkorn University
[2] Thailand Cyber University project (TCU)
Ministry of Higher Education, Science, Research and Innovation, Thailand
[3] Slipakorn University
[4] Sripatum University

Thai MOOC Academy is a national digital learning platform that has been serving as a mechanism for promoting lifelong learning in Thailand since 2017. It has recently undergone significant improvements and upgrades, including the implementation of a credit bank system and a learner's e-portfolio system interconnected with the platform. Thai MOOC Academy is introducing a national credit bank system for accreditation and management, which allows for the transfer of expected learning outcomes and educational qualifications between formal education, non-formal education, and informal education. The credit bank system has five distinct features, including issuing forgery-prevented certificates, recording learning results, transferring external credits within the same wallet, accumulating learning results, and creating a QR code for verification purposes. The paper discusses the features and future potential of Thai MOOC Academy, as it is extended towards a sandbox for the national credit bank system in Thailand.

1 Introduction

Thailand has made significant progress in the development of its educational system over the past few decades. However, there is still a need to provide individuals with access to lifelong learning opportunities, which is essential for the development of a knowledge-based society [5]. Thai MOOC Academy was launched in 2017 with the aim of promoting lifelong learning by providing accessible and affordable learning opportunities for individuals across the country.

Thai MOOC Academy is a national digital learning platform that has been promoting lifelong learning in Thailand since its launch in 2017. Over the past five years, it has grown significantly, with over 1.4 million members and more than 530 courses available as of February 24, 2023 (https://thaicyberu.go.th). The platform has recently undergone significant improvements and upgrades, including the implementation of a credit bank system and a learner's e-portfolio system interconnected with the platform. The credit bank system allows for the transfer of expected learning outcomes and educational qualifications between formal education, non-formal education, and informal education. This paper elucidates the characteristics and prospective advancements of the Thai MOOC Academy as it expands its scope to encompass a sandbox platform for the national credit bank system in Thailand.

The National Credit Bank System is an instrument for administering and validating lifelong learning in Thailand. Recently, [3] promulgated new regulations and procedures concerning credit banking, credit transfers, and credit accumulation in higher education. The Thai MOOC Academy has implemented a credit bank system characterized by six unique attributes, including:

1. Provision of forgery-resistant certificates in PDF format, with learner, course, and learning outcome details, augmented by the digital signature of the certifying agency. The document's forgery resistance aligns with the standards employed for university digital transcripts.
2. Logging of learning outcomes.
3. Aggregation of learning outcomes.
4. Capability to transfer external credits within a single wallet.
5. The system's capacity to pull data from learning certificates without needing to access information on Thai MOOC Academy.
6. Generation of QR codes to validate accuracy and streamline access to basic information [9, 6].

The credit bank system addresses the necessity for a mechanism that recognizes learning outcomes attained via non-formal and informal learning channels, such as MOOCs. It enables credit transfers between diverse learning types, encompassing formal, non-formal, and informal education [3]. Consequently, learners can amass credits from various sources and apply them towards securing a degree or certification. The learning process and credit bank of Thai MOOC Academy are presented in Figure 1.

Thai MOOC Academy Features and Future Potential Thai MOOC Academy is a national digital learning platform that has implemented the national credit bank system for accreditation and management. The platform also offers an e-portfolio system interconnected with the credit bank system, which enables learners to

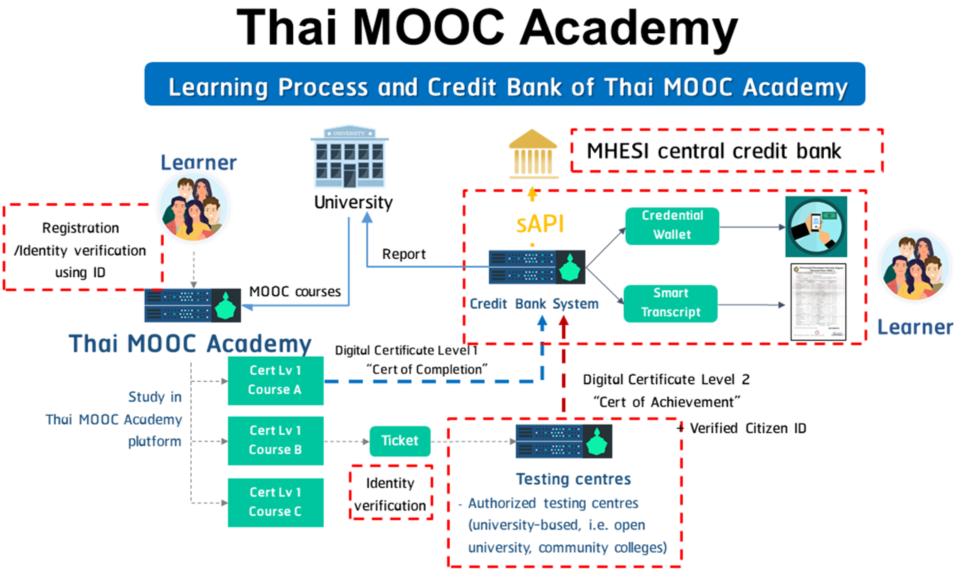

Figure 1: The learning process and credit bank of Thai MOOC Academy [6]

record their learning outcomes and achievements [9, 6]. This system provides learners with a record of their achievements that they can use to demonstrate their skills and competencies to potential employers. Thai MOOC Academy is an effective tool for promoting lifelong learning in Thailand. It has grown significantly over the past five years, with over 1.4 million members and more than 530 courses available. The platform has been recognized by various organizations for continuing education credit, including the Pharmacy Council of Thailand and Thailand Nursing and Midwifery Council. The Office of Vocational Education Commission (OVEC) under the Ministry of Education has also signed a memorandum of understanding to utilize Thai MOOC as a digital learning platform for fostering quality and enhancement of vocational education in the country.

In addition, Thai MOOC Academy has been extended towards a sandbox for the national credit bank system in Thailand. This means that the platform will continue to play an important role in accrediting and managing lifelong learning in the country. The credit bank system implemented by Thai MOOC Academy has the potential to promote lifelong learning by allowing learners to accumulate credits from different sources and use them towards obtaining a degree or certification. In addition, the credit bank system has the potential to reduce the cost and time needed to obtain a degree or certification, as learners can use credits from non-formal and informal learning to fulfill some of the requirements for formal degrees or certifications [9, 6, 8].

The implementation of the national credit bank system on Thai MOOC Academy also has the potential to benefit learners from disadvantaged backgrounds who may not have access to formal education. By recognizing non-formal and informal learning, the credit bank system can provide opportunities for these learners to obtain recognition for their skills and competencies, and ultimately improve their job prospects [2, 1]. The national credit bank system also aligns with the goals of the 13th National Economic and Social Development Plan, which aims to transform Thailand into a progressive and sustainable society by promoting human development and innovation [4]. By providing opportunities for lifelong learning and recognition of skills and competencies, the credit bank system can contribute to the achievement of these goals. Credit accumulation in the Thai MOOC Academy's credit bank system is shown in Figure 2.

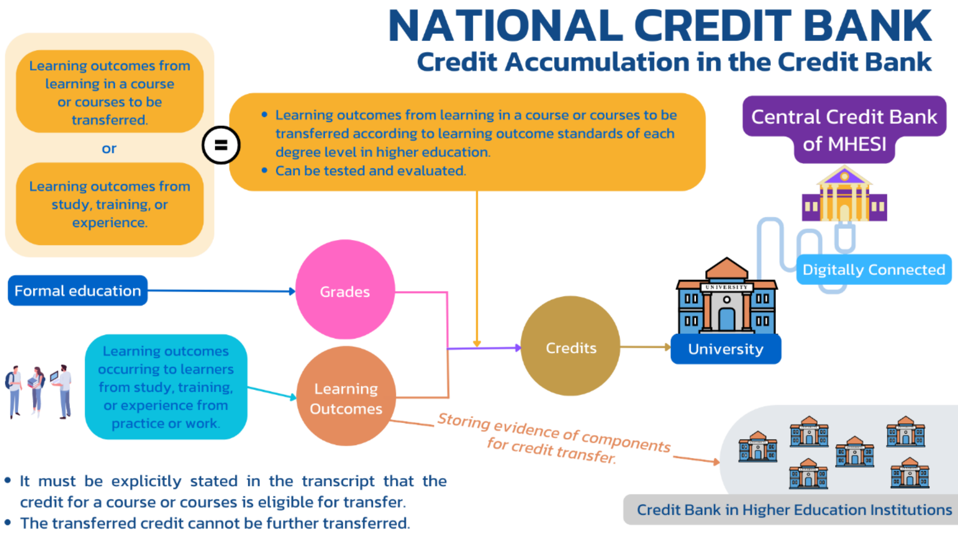

Figure 2: Thai MOOC Academy: Credit accumulation in the in the credit bank [7]

2 Future work

Potential future advancements related to the evolution of the ThaiMOOC Academy as a testbed for the national credit bank system in Thailand can be identified across several domains. Firstly, sustaining collaboration among academic institutions and organizations is essential to augment the offerings of the ThaiMOOC Academy and guarantee the quality of the provided courses and programs. Secondly, it will be crucial to supervise the implementation and efficiency of the credit bank and e-portfolio systems. This scrutiny will facilitate the identification of improvement areas and ensure the systems satisfy the requirements of learners and educational establishments. Thirdly, an ongoing need exists for research evaluating the ThaiMOOC Academy's impact on lifelong learning and strategies to foster platform usage among a diverse range of learners. In addition, broadening partnerships with more educational institutions, both nationally and internationally, could enrich the variety of the platform's course offerings. The Thai MOOC, developed based on Open Edx, an open-source MOOC platform, allows for effortless course exchange with other MOOC providers. In terms of compatibility, it enables straightforward transfer of Thai MOOC courses to other platforms and vice versa. A significant challenge for Thai MOOC, however, lies in overcoming the language barrier. To this end, Thai MOOC has been investigating the utilization of AI technology for content translation into Thai. This could facilitate precise translation of MOOC courses, and eventually, enhance the level and volume of cooperation between MOOC platforms. This could potentially lead to a significant increase in exchanged courses, thus paving the way for the effective implementation of the credit bank and e-portfolio systems in the imminent future. Operation of Thai MOOC Academy is shown in Figure 3.

3 Conclusion

In conclusion, Thai MOOC Academy has been a significant contributor to promoting lifelong learning in Thailand since its inception in 2017. The platform has grown significantly, with over 1.4 million members and more than 530 courses available as of February 24, 2023. Its recent implementation of the national credit bank system has enhanced its potential even further. The credit bank system offers learners greater flexibility and accessibility in their education journey, as well as provides opportunities for recognition of prior learning and non-traditional forms of education. The credit bank system's unique features, including forgery-prevented certificates, learning result recording, credit transfer, and QR code verification, have made it an effective mechanism for accrediting and managing lifelong learn-

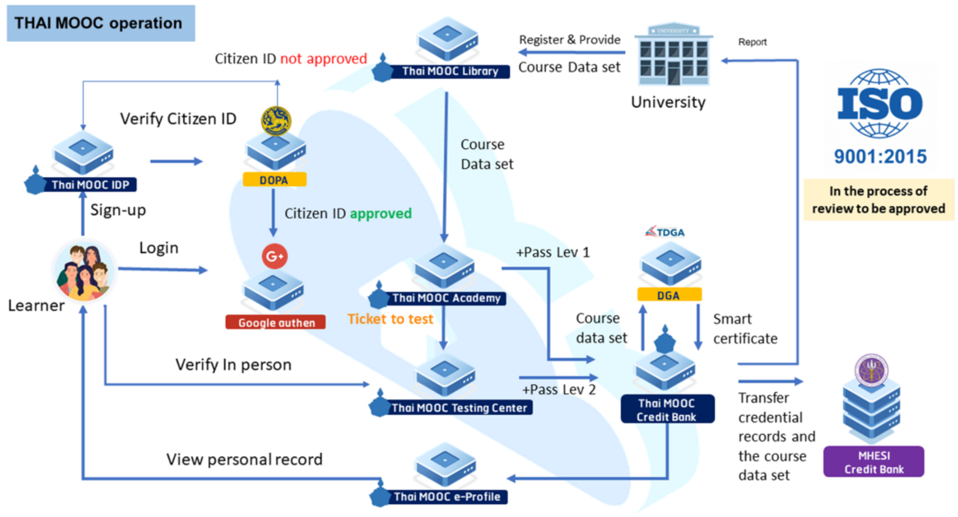

Figure 3: Operation of Thai MOOC Academy [7]

ing. However, it is essential to continue expanding and developing this system to fully realize its potential.

With ongoing support from both public and private sectors, Thai MOOC Academy has the potential to further promote lifelong learning and enhance human development in Thailand. The implementation of the credit bank system in Thai MOOC Academy aligns with the goals of the 13th National Economic and Social Development Plan, which aims to promote human development and innovation in Thailand. The system's potential to reduce the cost and time needed to obtain a degree or certification, provide opportunities for learners from disadvantaged backgrounds, and promote lifelong learning makes it an essential part of Thailand's education system. As such, the continued development and expansion of Thai MOOC Academy and its national credit bank system are necessary for promoting lifelong learning and enhancing human development in Thailand.

Acknowledgment

This paper is part of the Thai MOOC (Thai Massive Open Online Course) project, a national digital learning platform, which is a flagship project officially launched by Thailand Cyber University (TCU), Ministry of Higher Education, Science, Research and Innovation, Thailand.

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Impact Assessment of a MOOC Platform

Considerations, Development, and Results

Martin Ebner[1], Sarah Edelsbrunner[1], Katharina Hohla-Sejkora[1], Bettina Mair[1], Sandra Schön[1], Silvia Lipp[2], Iris Steinkellner[2], Ivana Stojcevic[2], and Charlotte Zwiauer

[1] Graz University of Technology, Graz
[2] University of Graz, Graz
[3] University of Vienna, Vienna

In 2020, the project "iMooX – The MOOC Platform as a Service for all Austrian Universities" was launched. It is co-financed by the Austrian Ministry of Education, Science and Research. After half of the funding period, the project management wants to assess and share results and outcomes but also address (potential) additional "impacts" of the MOOC platform. Building upon work on OER impact assessment, this contribution describes in detail how the specific iMooX.at approach of impact measurement was developed. Literature review, stakeholder analysis, and problem-based interviews were the base for developing a questionnaire addressing the defined key stakeholder "MOOC creators". The article also presents the survey results in English for the first time but focuses more on the development, strengths, and weaknesses of the selected methods. The article is seen as a contribution to the further development of impact assessment for MOOC platforms.

1 Introduction

In 2012, the University of Graz and Graz University of Technology (TU Graz) submitted a project proposal to the Province of Styria to establish a platform called iMooX, to bring together Massive Open Online Courses (MOOCs). The first MOOC, i.e. a free, openly accessible online course aimed at a huge number of people, was hosted on the platform in 2014 [10]. Since its launch, around 200 MOOCs have been implemented on the platform. They are usually available for independent, autonomous learning on the course platform for several months after a guided or supervised phase ends. For all universities that want to offer MOOCs on iMooX.at, there is also support for the conception of MOOCs or even workshops for creating OER in general. In 2020, as part of the call for proposals "Digital and Social

Transformations in Higher Education" of the Austrian Federal Ministry of Education, Science and Research (BMBWF), the project "iMooX – The MOOC Platform as a Service for all Austrian Universities" was launched, which aims to further develop the iMooX.at platform into a national MOOC platform. In this context, the Graz University of Technology and the University of Vienna are responsible for testing and adapting the technical, media-didactic, and organizational capacities accordingly and for producing MOOCs on a larger scale and offering them on the platform; at the same time, all Austrian universities will be able to implement MOOCs on the platform free of charge during the project period (2020–2023). This means that the comprehensive services of the platform – i.e. information, training of the creators, support of the MOOC participants as well as hosting the MOOCs for Austrian universities – are offered free of charge during the project. In this way, the platform also contributes to competence development in formal and informal learning. About two years after the start of the project, the project team wanted to draw a preliminary conclusion regarding the impact of the MOOC platform respectively the co-funded project.

Particularly when MOOC platforms are set up with the help of funding – which is the norm – the question arises whether the desired results and impacts have been achieved thanks to the funds invested. Obviously, the number of MOOCs and the number of participants is an indicator often used to confirm this. At the halfway point of a funding program for the Austrian MOOC platform "iMooX.at", the options for measuring impact were explored extensively. In this paper, we would like to present the approach in a broader context and address opportunities for the impact measurement of MOOCs and MOOC platforms.

2 Approach

In this article, we will first present the possibilities and approaches of impact measurement in the context of MOOC platforms. Since the Austrian MOOC platform only offers courses with Creative Commons licenses or, in the best case, openly licensed courses, we will also look at impact research in the context of open educational resources (OER). We will then present the approach chosen for investigating the impact of iMooX.at, and a questionnaire for MOOC creators was developed.

This contribution is based on an already published research article, where the impact assessment results were presented in German [3]. With this contribution, the methodological assumptions and development will be enriched and explained in more detail for an international target group with the idea to foster the discussion on the MOOC platform impact. Therefore, we also want to reflect on the approach and method to systematically contribute to and stimulate the discussion of impact research on MOOC platforms.

3 Impact Measurement: Ideas and concepts

3.1 Conceptual insights on impact research in the field of OER

MOOCs available as OER can be seen as digital social innovations [13]. Ebner, Orr & Schön [4] explored how an impact measurement of OER might be conducted. In general, from the perspective of a funding organization that wants to examine or evaluate the achievement of goals and the effectiveness of their funding or inputs, a distinction is generally made [7] between outcomes (outputs, results) and impact (consequences of results) that can be counted, measured, and listed [4]. Measurable indicators should be used so that their fulfillment can also be used to indicate changes. Impacts are more long-term and may include some indirect effects that are difficult to measure because the intervention contributes significantly, but not exclusively, to their achievement.

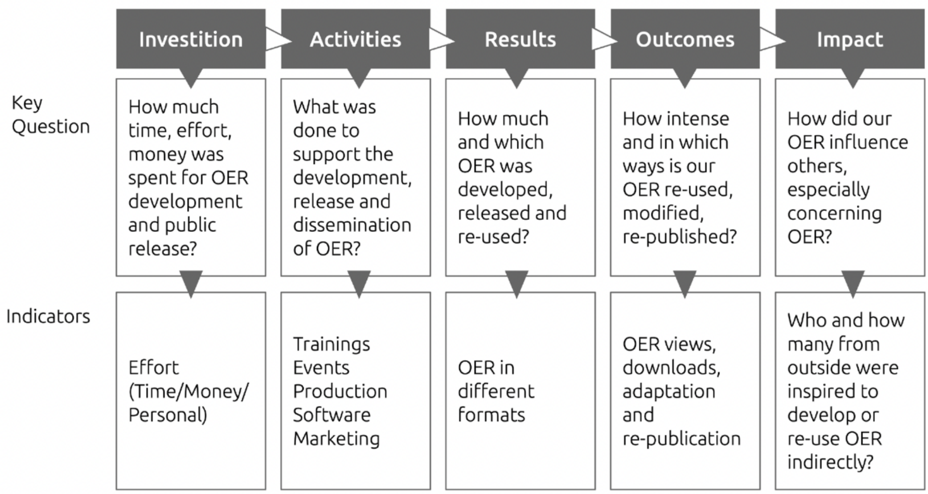

Figure 1: Potential key questions and relevant indicators from investments on the core of OER.
Source: Ebner, Orr & Schön, 2022, Fig. 4, [4, page 304].

Figure 1 shows key questions and indicators that are solely relevant for their OER aspect: The possibility to share, adapt, and download the existing resources; or if someone is inspired by existing OER and starts to develop their own. For measuring the MOOC platform impact, developing a set of fitting key questions and indicators might be necessary.

3.2 A glimpse into literature: examples of impact research of MOOC platforms

The search for impact research in the field of MOOCs (using Google Scholar, searched in August 2022) yielded a few relevant hits. For example, one paper addresses the impact of MOOCs by analyzing the relationship between the use of a platform and students' grades [14]. Other papers explore, for example, the role of prior experience in MOOC use [1] or the impact of open publishing on MOOC degree recognition [12]. At the ERIC subject database, other relevant contributions include Hakami [8] describing how the use of a MOOC in teaching has extended traditional learning and Nascimbeni et al. [11] identifying different collaboration patterns that can develop through OER. Further snowballing research led to articles that have explored the impact of MOOCs, especially openly licensed MOOCs such as at iMooX.at [2]. For the iMooX.at platform, Ebner and Schön have reported on how novel design principles are developed (Inverse Blended Learning, [5]) or how MOOCs can be integrated into learning settings in various ways, some of which are also novel [6]. Similar developments, especially regarding learning innovations, also seem to play a role in other MOOC platforms, as indicated, for example, by the description of new forms of learning [9].

This initial literature review reveals very few works in the impact measurement of MOOCs that allow for broad adoption of content-related or also methodological considerations for the impact measurement of a MOOC platform.

3.3 The open issue: what is the relevant impact (at all)?

After looking at the different ideas in the literature, we tried to adapt Figure 1 concerning the iMooX platform issues. Investment, activities, results, and outcomes seems to be an obvious and straightforward way to define key questions and indicators. It is obvious that first, it needs to be clarified what is perceived as an impact in our specific case of the MOOC platform, see Figure 2. And beyond that, the question arises: Who can provide well-founded information about (possible) impact?

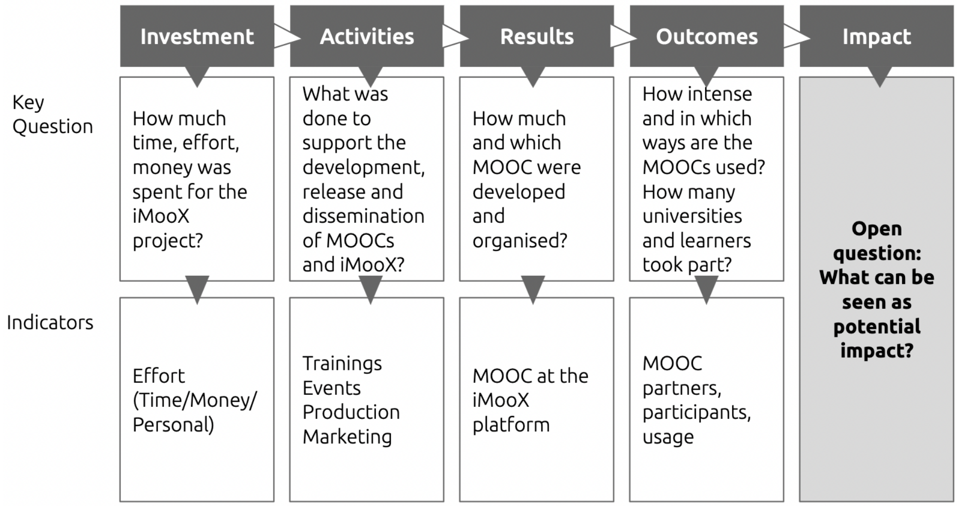

Figure 2: Potential key questions and relevant indicators from investments on iMooX to the open issue of "impact".

4 Impact Measurement development for imoox

4.1 Overview of the activities of impact measurement

The following will present the approach taken with the MOOC platform iMooX.at. To illustrate the (potential) impact of the iMooX project or the same-named platform, the following steps were conducted:

1. In a first step, potentially relevant stakeholders of the iMooX.at platform or MOOCs where impacts might occur were identified.
2. At the same time, the activities, results, and outcomes of the iMooX.at project were presented descriptively. For this purpose, quantitative survey indicators were chosen, which, in addition to the number of MOOCs and the activities they contain, also record the number of participants in the MOOCs.
3. To identify possible variations and characteristics of the platform's impact on the various stakeholders, five guided problem-centered interviews were conducted with selected Austrian MOOC creators at universities. Based on the interview results, a questionnaire with standardized question formats was developed.

4. The online questionnaire was sent to all course creators at iMooX.at and the gathered data was analyzed using descriptive statistical methods.

Overall, a conscious effort was made to be able to describe the quantitative aspects of the impact. This was also done to be able to make comparisons and describe developments in future surveys. The development of the method was carried out in a research cooperation with a colleague from the University of Graz and two students as well as with the help of the iMooX.at team.

4.2 Defining stakeholders

The starting point for researching possible effects was to consider which people and institutions might be "affected" by the MOOC creation, organization, and implementation at iMooX. These stakeholders represent the target group for the survey of possible impacts, i.e. expectations, objectives, changes, effects, or lessons learned. In the case of iMooX.at, there is one contact person for each (planned) MOOC, called "course creator". This person may or may not also be the teacher responsible for the course content. Typically, the MOOC team includes several people, namely those who support the development of the course concept, the creation of the videos and the course materials, and the implementation or even the promotion of the MOOC. This team usually includes three to ten people, sometimes even more. During MOOC development and implementation, collaborations with other institutions, i.e. other universities, organizations, and individuals, occur, for example, in MOOC conceptualization, content creation (e.g. interviews/lectures with external parties), or also in MOOC promotion and recognition. Participants of MOOCs are often students of the MOOC-creating university but may also be students from other universities. In addition, some MOOCs are offered to working professionals and are therefore not directly designed for students. The MOOCs at iMooX.at can also be used as OER by other institutions or universities without any dedicated cooperation. Thus, parts of a MOOC can be integrated into a course or participation in a MOOC can be part of a course. Figure 3 illustrates an example of a composition of different actors on which MOOC development and implementation can have an impact.

4.3 Exploring the potential impact through interviews

To identify possible variations and characteristics of the platform's impact on the various stakeholders, we conducted problem-centered interviews with our key stakeholder, the "course creators". In developing the guidelines, we ensured that in each interview there is enough space and time to ask about impacts for all stakeholders involved.

Table 1: Structure and guiding questions of the problem-based interview

Impact on the creator (interview partner)	1.1 Please report on your own MOOC. What course did you create, and what did you look for when creating it?
	1.2 Please tell us what motivated you to create a MOOC.
	1.3 Who was involved in the creation of your MOOC?
	1.4 What positive aspects or challenges have you experienced in creating or delivering MOOC courses?
Impact on the team / at their own university	2.1 What were the expectations within the team and your university for MOOC development and delivery?
	2.2 To what extent did these expectations become a reality?
	2.3 What effects did the MOOC creation and implementation have ? – On you personally? On the team? On your university?
Impact on the cooperation partners	3.1 What do you think were the expectations of your cooperation partners regarding MOOC development and implementation? (Why did they participate)?
	3.2 To what extent did these expectations become reality, can you assess that?
	3.3 What effects did the MOOC creation and implementation have on your cooperation partners?
Impact among the participants and other users	4.1 Who has participated in MOOCs and what do you think have been the effects of participation for the (different) people?
	4.2 What do you think are the effects of having people from outside your immediate scope participate in the courses?
	4.3 Do you know anything about other users, e.g. institutions that use course materials in their teaching or other institutions that have integrated the MOOC into courses or continuing education?
Conclusion	5.1 Have you already taken a MOOC yourself? If so, please report on your experience.
	5.2 Can you think of any other impacts we haven't touched on that your activities around MOOCs might have?

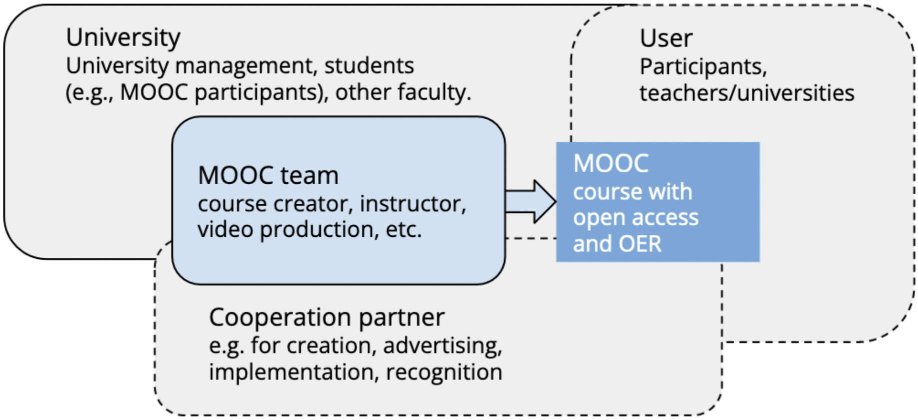

Figure 3: Identified stakeholders in MOOC development and implementation at iMooX partner universities.

Subsequently, five problem-centered interviews were conducted with selected MOOC creators. The interviewees were chosen in such a way that they had already (co-)developed several MOOCs. All interviews were transcribed, and a list of possible effects was generated, an excerpt of which is as follows:

- Changes in teaching and learning settings (e.g. flipped classroom).
- Sustainable teaching (reuse and adaptation of MOOCs).
- Increased motivation because there is interest in courses due to free choice.
- International standardization of course content by sharing MOOCs with other universities.
- Stronger networking with other universities (e.g. exchange or translation of MOOCs).
- Stronger networking with schools (especially HTL,Höhere Technische Lehranstalten, upper secondary schools in Austria with a technical background) for better preparation for studies).
- Stronger promotion of university content.

These and several more were collected, then sorted and transformed into a questionnaire with standardized questions.

4.4 Developing a questionnaire on the impact through standardized options

Like the previous approach, the questionnaire was designed to address the target group of MOOC creators. As a result, some questions are also carefully worded so participants do not need to commit to their answers – as they may only sometimes be able to answer them accurately. Again, as with the guideline, there are questions about the identified stakeholders in the questionnaire. The exact structure can be seen below as part of the result presentation.

5 Results after half of the project period

5.1 Activities and outcomes of the iMooX project

The project "iMooX – The MOOC platform as a service for all Austrian universities" started in March 2020. The number of project partners and the number of MOOCs offered are presented in Table 2. So far within the project duration, 41 MOOCs have been conducted by project partners and 29 MOOCs by other universities. In total, 70 MOOCs have already been carried out in the project or their production has started – this is far more than the goals stated in the project application (33 MOOCs including the non-binding letters of interest). The project activities also include the qualification of 125 people as certified course creators. Three so-called "MOOC summits" – one-day meetings with course creators with updates and workshops on the platform and project – also attracted around 70 participants. News about the platform and the courses have been distributed on the iMooX channels on Twitter, Facebook, and Instagram, and several publications about the platform have been published.

Table 2: Number of Austrian universities reached and their participation in MOOC production. Source: Internal documentation from iMooX. Source: [3, Table 1, p. 60].

Austrian universities and their MOOCs	**Goals at project start 03/2020**	**Status 09/2022**
Project partners (TU Graz, University of Vienna)	According to the application: 18 MOOCs	41 MOOCs
Austrian universities (not project partners)	Letters of intent on MOOC production from 15 universities	29 MOOCs from 20 universities (of which 10 universities with letters of intent) and 10 universities without LOI)

A total of 54,917 registered users are counted on the iMooX.at platform (as of September 2022). For the evaluation in Table 3, only such accounts were counted that can be clearly assigned to Austrian university members. Regarding the proportionally high number of MOOCs offered by the two project partners, it should be considered that both institutions not only provide a very large number of MOOCs, but also that Graz University of Technology has already been offering MOOCs on the platform since 2014 and the University of Vienna is the largest university in Austria (and thus can potentially reach more students). In the presentation, it should also be considered that accounts can also be deleted, and the related data is no longer available for data protection reasons, i.e. the data is not cumulative, but current data from the system. For this reason, it is also no longer possible to reconstruct how many accounts from Austrian universities there were in February 2020. The figures shown are snapshots; it is possible that more people were reached who unsubscribed again after successful participation. There is a clear increase in the number of universities that have produced or are producing MOOCs and in the number of universities that are officially using MOOCs. Additionally, the number of people from other Austrian universities registered is surprisingly high. Overall, the six-month period between the two surveys shows an increase of 8 for this target group, with around 1,400 additional university members registered.

Table 3: Number of Austrian university members reached (dedicated university accounts are counted here). Source: Internal documentation of iMooX.

Austrian university members from	**Status 03/2022**	**Status 09/2022**
Project partners (TU Graz, University of Vienna)	6.544	7.332
Universities that have produced or are producing MOOCs	5.914	6.481
Universities where MOOC use is known to occur	1.433	1.569
Universities where no official cooperation has (yet) taken place	2.825	2.725
Total	16.716	18.107

5.2 Impact analysis: Results of the survey among course creators

From July to August 2022, course creators were asked to participate in the survey on the effects of MOOCs. A total of 143 people were contacted, including those responsible for the first MOOCs in 2014 who, as it turned out, could no longer be reached using the contact details provided. Against this background and the fact that the survey was conducted during the summer vacation, the response rate of 17 fully completed questionnaires (12 %) is satisfactory. The results have already been presented and published in German [3], so in the following Table 4 we will only present the questions and the distribution of the answers. This allows to equally recognize the structure and questions and, if necessary, to make comparisons between the data in the future. A question at the end of each section asked if anything else might be added as a potential effect. To round things off, an open-ended question was asked about possible negative effects. The answers to the open questions are not presented in this paper.

Table 4: Answers to the survey among course creators (n = 17). Note: We ranked the answers from least to most agreement in each section.
The data was originally published in diagrams in [3, Figure 4-10].

	agree	rather agree	neu-tral	rather dis-agree	dis-agree	don't know
When creating a MOOC for iMooX . . .						
. . . I learned to pay more attention to comprehensibility/diction when teaching.	41,2	23,5	11,8	11,8	11,8	0,0
. . . I enhanced my digital skills.	58,8	11,8	11,8	5,9	11,8	0,0
. . . I learned new things in terms of the content of the MOOC.	58,8	11,8	5,9	11,8	5,9	5,9
. . . I extended my knowledge of OER and open licenses.	64,7	17,6	17,6	0,0	0,0	0,0
. . . I learned something new in general.	70,6	17,6	5,9	5,9	0,0	0,0
. . . I extended my knowledge of designing online courses.	76,5	11,8	0,0	5,9	5,9	0,0
I think when creating a MOOC for iMooX our MOOC creator team . . .						
. . . learned to pay more attention to comprehensibility/diction when teaching.	31,3	18,8	31,3	0,0	6,3	12,5
. . . has enhanced their digital skills.	37,5	6,3	31,3	6,3	0,0	18,8
. . . extended their knowledge of OER and open licenses.	50,0	18,8	6,3	6,3	0,0	18,8
. . . learned new things in terms of the content of the MOOC.	56,3	6,3	12,5	6,3	0,0	18,8
. . . learned something new in general.	56,3	12,5	12,5	0,0	0,0	18,8
. . . extended their knowledge of designing online courses.	68,8	6,3	6,3	6,3	0,0	12,5
For our institution, the creation of a MOOC on iMooX.at . . .						

	agree	rather agree	neu-tral	rather dis-agree	dis-agree	don't know
... has contributed to an increased exchange with companies.	6,3	0,0	18,8	6,3	56,3	12,5
... helped get staff interested in MOOCs and MOOC creation.	12,5	37,5	25,0	0,0	6,3	18,8
... has contributed to an increased exchange with other universities.	18,8	37,5	0,0	18,8	12,5	12,5
... has helped our institution to be perceived positively by the public.	31,3	18,8	12,5	0,0	6,3	31,3
... has helped to increase interaction with individuals outside the institution.	37,5	25,0	18,8	0,0	6,3	12,5
... has helped to increase interaction within the institution.	37,5	37,5	6,3	0,0	12,5	6,3
I think the participants in a MOOC at least						
... learned from the other participants.	25,0	6,3	18,8	25,0	0,0	25,0
... learned to learn/work more independently.	31,3	25,0	18,8	0,0	0,0	25,0
... benefited from the flexibility of content (individual modules can be used).	37,5	18,8	25,0	0,0	0,0	18,8
... enhanced their digital skills.	37,5	31,3	12,5	0,0	0,0	18,8
... participated because MOOCs are free of charge.	50,0	12,5	12,5	6,3	0,0	18,8
... benefited from the time flexibility.	62,5	18,8	6,3	0,0	0,0	12,5
... had a good experience with online learning.	68,8	18,8	0,0	0,0	0,0	12,5
... benefited from the spatial flexibility.	68,8	18,8	0,0	0,0	0,0	12,5
... learned new things in terms of the content of the MOOC.	87,5	6,3	0,0	0,0	0,0	6,3
For MOOCs you have created that are used in university courses, the following statements apply (this was applicable for $n = 12$**)**						
MOOCs are also used in other courses at other universities.	25,0	16,7	16,7	0,0	16,7	25,0
MOOCs are positively transforming teaching.	33,3	33,3	16,7	8,3	0,0	8,3
MOOCs as a component of courses relieve teachers.	41,7	16,7	16,7	8,3	16,7	0,0
MOOCs bring variety to teaching.	50,0	41,7	0,0	8,3	0,0	0,0
The use of MOOCs in courses opens-up a new didactic-methodological scope.	58,3	25,0	8,3	0,0	8,3	0,0

	agree	rather agree	neutral	rather disagree	disagree	don't know
For MOOCs offered as bridging courses, the following statements apply (this was applicable for n=5)						
MOOCs are more accessible to first-year students than face-to-face courses.	40,0	40,0	20,0	0,0	0,0	0,0
MOOCs prepare students well for their studies in terms of content.	20,0	80,0	0,0	0,0	0,0	0,0
To what extent do the following statements apply for MOOCs of the platform iMooX?						
No new "educational currency" can be developed by issuing MOOC certificates.	6,3	25,0	18,8	25,0	6,3	18,8
MOOCs do not contribute to the improvement of education.	25,0	0,0	0,0	12,5	62,5	0,0
The iMooX.at platform encourages the use of other MOOCs.	43,8	37,5	6,3	6,3	0,0	6,3
MOOCs promote sustainable development of educational materials because they can be reused/adapted.	75,0	12,5	6,3	0,0	6,3	0,0
MOOCs can reach a larger group of people for a topic.	81,3	12,5	0,0	0,0	0,0	6,3
MOOCs provide free access to education.	93,8	6,3	0,0	0,0	0,0	0,0
iMooX.at contributes to the dissemination of open educational resources.	93,8	6,3	0,0	0,0	0,0	0,0

As a summary, we will shortly emphasize the most important results concerning the effects of the MOOC developments and iMooX from the perspective of a course creator:

A critical insight from the survey is that most of the course creators have expanded their knowledge of online course design; the majority also learned something new and expanded their knowledge of open licensing. More than half have also learned something about the subject area of the respective MOOC as well as developed their digital skills. The statement that knowledge about OER and open licenses has been expanded among the course creation team receives the highest level of agreement. The statement that the team learned something new in general or in the subject area of the MOOC is confirmed by slightly more than half of those surveyed.

Regarding the effects on the institutions themselves, it is noticeable that overall they have not been affected to the same extent as the previous groups who were directly involved (see Table 4). Accordingly, more than half see an increased exchange within and outside the institution because of the MOOC. Around half state that their own institution is perceived positively by the public because of the MOOC. In contrast, only one person indicated an increased exchange with companies, so this does not seem to be the norm.

Concerning the impact on participants from the point of view of the course creators,¸ the most obvious effect on MOOC participants, namely that they have learned something about the MOOC topic in question, is confirmed. Almost all course creators also think that their participants had a good experience with online learning and benefited from the flexibility in terms of time and space and the fact that it is free of charge.

Some respondents (n = 12) have created MOOCs that were used as part of university courses. The majority here perceived statements such as an increase in the didactic-methodical scope, variety in teaching and positive change in teaching as an effect. Five course creators have implemented MOOCs as bridge courses that are intended to prepare first-year students when they transfer to higher education. In each case, they assume that MOOCs offer good preparation in terms of content and are also easier to access than face-to-face courses.

Regarding the general impact of iMooX.at and MOOCs, there is extraordinary approval for all five positively formulated statements, as well as a corresponding rejection of the two negatively framed statements. All respondents (tend to) agree with the statement that iMooX.at contributes to the dissemination of OER and thus enables free access to education. The majority confirms that MOOCs can reach a larger group of people, promote the sustainable development of learning materials, lead to the improvement of educational offers and encourage people to use other MOOCs as well. Around a third assume that MOOC certificates could also represent a new "educational currency".

6 Discussion and Conclusion

With this paper, we have presented our thoughts on the possibilities of an impact analysis of a MOOC platform and the development and results of our implementation. Finally, it is necessary to evaluate our approach critically.

Even though the obvious result is to focus on course creators, this was not so clear at the beginning. We have also considered conducting surveys among users of the platform. The clear advantage of our approach is that it allows us to catch people with a relatively high level of insight. Of course, one major disadvantage is that course creators can only report from their perspective. The participants also saw and addressed this problem in the interviews: It is difficult to assess the effects on third parties from their perspective.

It would be interesting to explore an even broader approach than in our case through problem-centered interviews with the course creators: Through conversations with participants, partners and external users, further (possible) effects could certainly be identified. Effects of MOOCs and the platform could also be integrated more strongly into user surveys in the future. At iMooX.at, these currently primarily contain general indicators of satisfaction with the MOOCs and the platform and do not address the effects of the MOOCs.

Acknowledgment

This report is based on an analysis carried out within the framework of the project "iMooX – The MOOC platform as a service for all Austrian universities" (2020–2023, partners: the Graz University of Technology, University of Vienna). Special thanks go to our colleagues and co-authors at the University of Graz, who contributed significantly to the impact analysis project by conducting the problem-centered interviews with course creators and developing the online survey.

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From MOOC to “2M-POC”

An approach to Transform a Traditional MOOC to an Efficient Multi-Modal Learning Path for Companies

Maria Thirouard, Marie de la Villèsbrunne, and Oliver Bernaert

IFP School
maria-alejandra.thirouard@ifpen.fr | marie.le-saige-de-la-villesbrunne@ifpen.fr | olivier.bernaert@ifpen.fr

IFP School develops and produces MOOCs since 2014. After the COVID-19 crisis, the demand of our industrial and international partners to offer continuous training to their employees increased drastically in an energy transition and sustainable mobility environment that finds itself in constant and rapid evolution. Therefore, it is time for a new format of digital learning tools to efficiently and rapidly train an important number of employees. To address this new demand, in a more and more digital learning environment, we have completely changed our initial MOOC model to propose an innovative SPOC business model mixing synchronous and asynchronous modules. This paper describes the work that has been done to transform our MOOCs to a hybrid SPOC model. We changed the format itself from a standard MOOC model of several weeks to small modules of one week average more adapted to our client’s demand. We precisely engineered the exchanges between learners and the social aspect all along the SPOC duration. We propose a multimodal approach with a combination of asynchronous activities like online module, exercises, and synchronous activities like webinars with experts, and after-work sessions. Additionally, this new format increases the number of uses of the MOOC resources by our professors in our own master programs.

With all these actions, we were able to reach a completion rate between 80 and 96 % – total enrolled –, compared to the completion rate of 15 to 28 % – total enrolled – as to be recorded in our original MOOC format. This is to be observed for small groups (50–100 learners) as SPOC but also for large groups (more than 2500 learners), as a Massive and Multimodal Private Online Course (“2M-POC”). Today a MOOC is not a simple assembly of videos, text, discussions forums and validation exercises but a complete multimodal learning path including social learning, personal follow-up, synchronous and asynchronous modules. We conclude that the original MOOC format is not at all suitable to propose efficient training to companies, and we must re-engineer the learning path to have a SPOC hybrid and multimodal training compatible with a cost-effective business model.

1 Introduction

IFP School is an engineering school that offers applied graduate programs, providing students and young professionals with education in the field of energy and mobility. Our main concern is to meet the needs of the industry in terms of skills with a particular emphasis on providing applied knowledge on sustainability and innovation.

MOOCs and online courses have been around for some years now. As many institutions, IFP School entered the world of online courses initially to address three main goals: to increase institutional visibility, to keep the leadership in education and new learning techniques and to provide training for our staff in these new digital learning tools.

With these three goals in mind, the very first-generation MOOCs of IFP School were produced and proposed to an open public. "Sustainable Mobility" was released in 2014 while MOOC "Oil&Gas" was released in 2015. Both consisted of a series of videos and evaluations to assess learners' knowledge. Some parameters and features were chosen to guarantee learners' motivation and completion. For instance, it has been proven that learning through games and playing is one efficient way to improve the learning experience. In consequence, most of the evaluations proposed were chosen and designed as mini games or serious games. Another example was to include storytelling techniques with characters that invited learners to move forward in the activities. Even the choice of short videos (between five and ten minutes) helped guarantee that learners would stay focused until the end.

All these engagement tools and their effects have been explained in former eMOOC conference papers [6, 5, 7, 4].

Some figures regarding the first editions of these MOOCs are presented in Table 1. The completion rate is presented in two ways: (1) the number of certified participants against the total number of enrolled participants and (2) the number of certified participants against the number of active participants (participants that have started at least one video or activity). Both courses were open to anyone completely free.

Table 1: First generation of IFP School MOOCs data

	Total enrolled	Completion rate (total enrolled)	Completion rate (active participants only)
"Sustainable Mobility"	3099	31 %	59 %
"Oil&Gas"	21840	28 %	67 %

The completion rates obtained by both MOOCs were impressively high compared to the average completion rate data available at the time. Even more, each MOOC was run three times in a one-year interval with equivalent results in terms of number of participants and completion rate. The experience was a success beyond expectations. Even though the business idea was not included in the original design of these MOOCs, the school perceived an indirect return of investment that was impossible to quantify in terms of income but enough to continue with the experience.

Two new, second-generation MOOCs were produced with similar goals: "Tomorrow's Mobility" in 2018 and "Energy Transition" in 2019. At the time, our main concern was to improve our visibility in new fields (cleaner energies and cleaner forms of mobility) matching the evolution of the content of our programs and the needs of society in terms of skills. Some pedagogical innovations were included like serious escape games or the addition of a sketch notes conclusion to highlight the main ideas at the end of the videos. The course difficulty was also increased for "Tomorrow's Mobility" and decreased for "Energy Transition", compared to the first two MOOCs. The table below shows the results for the first editions of the second-generation of IFP School MOOCs.

Table 2: IFP School second generation data

	Total enrolled	Completion rate (total enrolled)	Completion rate (active participants only)
"Tomorrow's Mobility"	4981	20 %	57 %
"Energy Transition"	25834	19 %	68 %

As before, each of the MOOCs was proposed to an open public during three editions, with the latest editions overlapping with the COVID-19 pandemic situation. The graph (Figure 1) below shows the comparative results for the three editions of the second-generation MOOCs: even though the completion rates were still very promising, it was clear that the MOOC format was slowly losing the massive public it initially captivated.

The figures regarding the MOOC participants also show that the targeted audience (students) was very often outnumbered by professionals. Taking a closer look at the profile of participants, we could see many employees from industrial companies taking our MOOCs (up to 1000 employees from the same company: this number is certainly underestimated since we could only track those participants using their professional email address). For example, MOOC "Energy transition's"

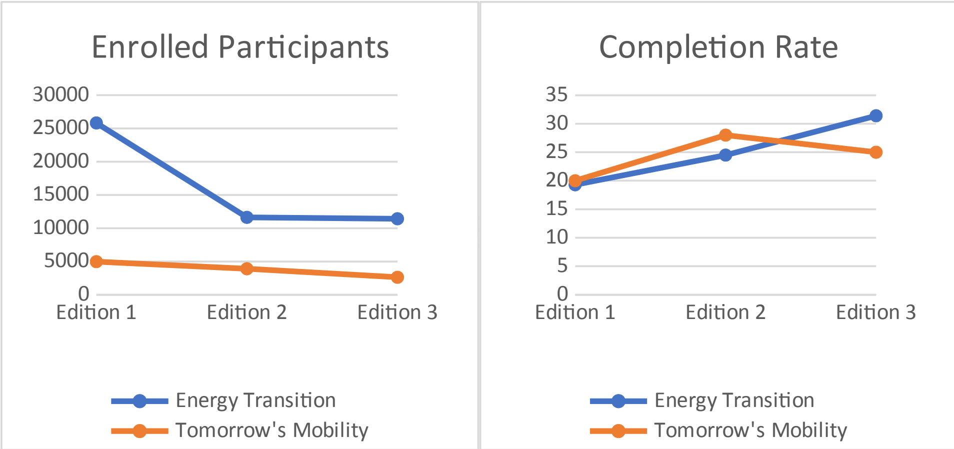

Figure 1: Comparison of three editions, second generation of IFP School MOOCs

third edition saw 64 % of professionals registered compared to 26 % of students (the first edition had 31 % of students while the second one had 35 %).

At the same time, some industrial partners asked the school to run some of the MOOCs as Small Private Online Course or so-called SPOC. The business idea started to grow as a result of several aspects combined:

1. The needs of the industry to educate their employees with new skills using digital techniques that provide reduced cost. It was seen that MOOC formats were not completely adapted because the massive character implied general contents not matching specific needs for a company.

2. The education needs are changing at a pace that makes it difficult for traditional schools to adapt even if there is a strong will to keep up the pace. It goes beyond the digital world where it is common to see a fast rate change of technology. The skills needed by industrials in the energy and mobility sectors are also quickly changing and it demands continuous learning from the employees. As an example of this idea, students that received a Powertrain Engineering degree from IFP School in 2019 were working in 2021 on an already new subject of hydrogen mobility that was not addressed during their studies.

3. Investments in terms of time and money were extremely important. The MOOCs were included in the curriculum of some of the IFP School master programs, but the use in the master programs was not enough to justify such an investment. The massive character of online courses is what makes it economically

sustainable, as well as the original fundings. The school could not continue to support the MOOC activity without including the development of a business model including industrial partners.

4. Finally, the COVID-19 situation impacted the interest of learners for traditional MOOCs. Many reasons can explain the situation. As a result, the interest in the courses dropped progressively with less participants following the MOOCs (see Figure 1).

The exponential growth in the numbers of MOOCs – oriented for students, as a soft marketing tool – is finished. It is time for a new format of digital learning tools. The COVID-19 pandemic has probably accelerated the phenomena. The aim of this article is to show how to adapt to the new reality education is facing, with a particular focus on continuous training for professionals. It explains the choices that have been made to produce learning devices that are meaningful, efficient and with controlled costs.

2 MOOCs AS Digital learning tools for industry

2.1 The companies' need

As explained in the previous section, we are facing times where continuous learning has become mandatory to keep track of the skills companies are looking for. Not only soft skills, but also hard skills. On the side of employees, the skills learnt during university might be soon outdated, as shown in the example of the Powertrain Engineering batch of 2019. The abilities to adapt, to learn and to change have become mandatory for professionals.

Companies play an important role in ensuring training and providing the skills for their employees' overtime. The ecological transition is an example of corporate culture transformation that requires continuous training. In a context where employees are more and more accountable for their training and employability [3], and where companies face radical and rapid transformations not only in terms of technical skills but also in terms of corporate culture, digital trainings like MOOCs seem to be a promising solution.

From the Human Resources department's point of view, MOOCs represent "a new opportunity for managers to rapidly reconfigure organizational resources at low cost in a competitive context that emphasizes the ability of any organization to adapt to change" [3].

3 The use of MOOC as free training content

Some external platforms started to inventory MOOC content[1] in 2013/2016, accompanying the trend of MOOCs and the need of individuals and companies to find content on specific subjects opening. It led the way to the use of COOC – Corporate Online courses [1]. However, experience shows that giving employees access to these training "buffets" does not necessarily give them the "willingness" needed to complete those courses [3]. This is especially true if there is a lack of motivation from the management, social interaction, and/or follow-up (most of the literature found about MOOC for corporate training are based on this use of MOOC to do so).

4 The use of MOOC to provide specific internal training

IFP School sees an opportunity to address the challenges faced by industrials to provide training to their employees in a massive and economically sustained manner. The goals of this new learning tool shifted basically because we are addressing the client's needs first instead of our three main goals described in the previous section. Our goal in this case is to adapt the lessons learnt from the MOOC experiences so we can provide the best learning experience for companies while improving or updating the content of our courses. When specific development is made on client's request, an agreement is made regarding the intellectual property of the content co-developed. If the content is confidential, IFP School has no right to use it outside the framework of the collaboration. An example of this case is the production of specific videos with experts from the client's staff. When non-confidential aspects are requested, the modifications are the property of the school, so it is possible to re-use it for: IFP School students, new clients, or as MOOC. An example of non-confidential modifications is the development of the course in a new language: once the videos are subtitled in a new language, IFP School is free to offer the course in all the available languages to another client. In both cases, the client pays for the new development.

To give more concrete information, two examples based on the "Energy Transition" MOOC content will be presented below. Both examples are based on a request to provide the MOOC "Energy Transition's" courses to industrial compa-

[1] My Mooc (http://www.my-mooc.com) was created in France in 2016, which pivoted to corporate training in 2018 an Fun MOOC was created in 2013 (http://www.fun-mooc.fr)

nies' employees. Both started with the query to give access to the MOOC content outside the free, public periods of operation.

The first questions asked were the ones of a user centric approach:

- Who is the targeted audience? (Quality and quantity)
- What are the learning objectives?
- Does the content of the MOOC answer these objectives?

4.1 Example 1 – From a first generation of MOOC to a SPOC

In 2020, a first industrial partner eager to take advantage of the COVID-19 crisis to train their employees contacted us showing interest in the public courses we had already published online. Since our policy was to have some periods of the year open to the public for free, companies thought it would be possible to give them access to the resources for free. Instead, we proposed to them a formula that combined engineering expertise, pedagogy expertise and the know-how on online training. It was for us the first time to fully grasp the added value of this combination, enough to make a business model out of it.

In addition to the original content, we added some of the client's resources to personalize the course and provide a meaningful experience:

- an introductory video with one of the top managers of the company was specifically made for this course.
- Live sessions were held on specific dates to give pace to the learning experience and answer participants' questions. Sessions were either Q&As given by experts on the MOOC-topics, or tutoring sessions to engage learners to finish the training and make the best out of it.

In addition to these lives, we also provided the client with an emailing guide for an adapted communication to the learners, a close follow up of the 75 learners who participated in the SPOC.

For this client, an innovative multi-modal approach was developed. Multimodal means in this case that some parts of the training are to be done at the participant's pace, or asynchronous, and some parts are done at the same time by all participants, or synchronous. Some examples of synchronous sequences are a live introduction session to give the context of the training, a follow-up session to share practices and give tips to complete the MOOC, and webinars with experts to answer questions on important subjects. Some examples of asynchronous sequences are online forums, documents and videos. The experience was framed by a specific communication campaign co-constructed with the company.

This first experience was a success beyond our expectations with 80 % completion rate. For us, two main factors directly contributed to this result: first, the high-quality training design (scientific content combined with the social learning approach), and second, the involvement on the client's side to motivate and follow the process, with the learning hub and the manager of the business unit working in close relationship with us.

4.2 Example 2 – From a MOOC to a "2M-POC" third generation of MOOC

This second example comes from another industrial partner. The request was taking place in an overall cultural shift of a major energy firm. The MOOC "Energy transition" was to be part of the training of all the employees (more than 7500) to reinforce the change of mindset of the company. There were two parts in the requests:

1. The content of the MOOC "Energy Transition" was to be provided in three sessions with 2500 learners on each session.
2. Specific content was to be produced for top management on key topics based on the strategic expertise of our research community at IFP Energies nouvelles.

The result so far is a great success: 5000 employees enrolled in total throughout two out of three sessions, 95 % and 96 % completion rate (against total enrolled participants), more than 53 % of active learners asking questions to experts or taking part in the discussions forums. This success is the result of a team effort between the learning community manager, and the client's training service who truly worked hand in hand to motivate participants to finish.

Leaving aside the second part of the demand that concerns the production of specific content for the client, the first part was quite a unique experience. In addition to the content, experts would answer questions on forums, resulting in more than 1500 messages (questions and discussions). This type of online training cannot be called a MOOC. By definition, a MOOC is open to everyone, which was not the case here. It cannot be called a SPOC either since having 5000 learners enrolled (7500 total with the 3rd session) places the experience outside of the boundaries of a Small Private Online Course. We decided to call this new format "2M-POC": Massive Multimodal Private Online Course.

Other clients followed these initial two experiences. It confirmed the possibility to use online content as a marketable service adding value to companies that need training for their employees that is easily available at an affordable price.

5 What is a “2M-POC” third generation of MOOC?

After 2020, a strategic study was performed to assess our partner's needs and to look for business opportunities. The influence of the business opportunities seen before led us in a new direction. The third generation of MOOC – internally called “2M-POC” – was designed as a short, multimodal, cost-efficient format.

5.1 A shorter format

Designing a full-length MOOC is very costly both financially and in terms of human resources, if you want to create the content internally. In a survey on the use of digital training in universities, one interviewee tells Bruillard [2]: “The rate of reuse of a digital resource was inversely proportional to its size. The smaller the resource, the easier it was for teachers to include it in their course”. Smaller “chunks” are easier, faster, and less expensive to make, ergo to update. This is important given the rapidity of changes in some of the topics. If a good number of “chunks” is produced, adapted training journeys can be designed by a personalized choice.

In a school, this approach has the advantage of blending better and easier in teachers' courses; and for industries, the advantage is to better address their needs. A topic can be addressed in a short, efficient way that is easy to introduce in a multimodal training path.

The “2M-POC” approach is a shorter version of the first-generation MOOCs where total duration was reduced from one month to multiple short standalone modules.

An example can be found in the course “Hydrogen for Mobility”[2]. The content was produced to address the need of the Powertrain master program to provide engineer level knowledge on hydrogen developments. The course is short and designed to be done in three to six hours. The advantage is that it easily fits into the program's schedules. On the industrial side, this short format meets the training requirements of our partners.

5.2 A sustainable business model

The original business model of MOOCs was not proven to be cost-efficient. *Udacity* was one of the first MOOC platforms to turn towards corporate training[3]. After

[2] https://academy.ifp-school.com/enrol/synopsis/index.php?id=201

[3] Schuman, R., 2013, The King of MOOCs Abdicates the Throne. Sebastian Thrun and Udacity's “pivot” toward corporate training. *Slate*.

2015 *EdX* and *Coursera* started to charge fees, other institutions tried to provide the course content for free and would offer the possibility to pay a fee to get an official certificate.

The first IFP School MOOCs – "Oil & Gas" & "Energy transition" – were made possible by the funding of industrial partners of the school. Fundings usually covered a part of the external costs regarding the development of the content, language adaptation or the platform costs. However, the cost of the internal human resources needed to develop the MOOC was supported internally and it was the biggest part of the budget. In some way, the income provided by these fundings to produce our first MOOCs was the beginning of the business model. For our sponsors, each campaign gave them the opportunity to train their employees, or future potential employees on a large scale.

Remember, at the beginning of the experience, IFP School MOOCs were used as a soft marketing technique: the search of a new image was the real target at the time. The idea was to reach qualified students all over the world, to promote the school and eventually get them enrolled in our master programs. Every student enrolled in the school is a source of income due to the tuition fees. Even if the MOOCs were entirely free (certificate included), an indirect income was received whenever a student came to the school because of our MOOCs. This was the hidden mechanism behind the strategy of the first MOOCs: 10 % of our students at the time got to know the school due to one of those MOOCs.

Third generation MOOCs ("2M-POC"), or "MOOC Chunks" are now designed on a specific demand: either coming from the internal IFP School side or coming from industrial partners. The course "Hydrogen for Mobility" initially developed for our master programs has found interested clients in our industrial partners since it is addressing a challenging topic.

These "chunks" can eventually serve as chapters of a full training path (e.g. "Hydrogen for mobility" to be included in a Hydrogen path).

A virtuous ecosystem

IFP School is part of IFP Energies nouvelles (IFPEN) – an industrial group that includes a research center, but also companies in the field of energy, mobility, and training dedicated to professionals.

In the first and second generation of MOOCs, most of the experts were teachers from IFP School, with few speakers coming from the research center. The MOOCs were designed for school communication with no real business strategy. In the third generation "2M-POC", sales objectives were considered at the beginning of each project. The MOOCs are now produced internally, by a dedicated structure called LAB e·nov™ – the digital culture laboratory of IFPEN, hosted by IFP School. For instance, video production is now also internal, with a multimedia studio facility located at LAB e·nov™.

IFPEN experts are often participants to create the videos, so the content is created in a "virtuous ecosystem". The idea is that the need to develop the content might come from any stakeholder in the ecosystem (IFP School, industrial partners, or clients, or even IFP Energies nouvelles research center). Research experts provide their knowledge through these "chunks" and they benefit from the pedagogical enhancement of the content by IFP School staff. IFP School receives high quality content that can be used for our students or for our industrial clients. The students usually serve as first users to test the modules. Asking our experts to produce the content is truly well received by their community because it gives them a showcase to their expertise.

5.3 A multimodal approach

In this third generation, we capitalized on MOOC deployment to keep the best practices for the asynchronous part. We stop considering a MOOC as a succession of videos and evaluations but kept them as central to constructing learning devices. The new "2M-POC" is designed to propose a real multimodal approach, mixing teaching modules and social aspects in a global training path (Figure 2).

Teaching modules
The modules are still mainly made from videos and documents to produce the training device. This asynchronous part is the center of the training. Additionally, in the "2M-POC" approach we propose other types of resources to obtain at the end of a relevant learning path. For example:

- flipped classroom,
- Q&A session to discuss with experts,
- specific lecture or a webinar at the end of a module to elaborate further on a specific topic,
- dedicated project or workshop where the students directly apply what has been taught.

For example, "Hydrogen for Mobility" is used by several masters at IFP School and is a mixture of six-hour flipped class resources, two additional live Q&A sessions, and a one-day application workshop using simulation tools. In parallel, it was deployed as a seasonal free MOOC training during students' application period and this campaign led to new industrial prospects.

Social approach
To complete the learning path and obtain a significative completion rate at the end of the module, the social aspects of the third generation MOOCs are also considered; for example:

- opening live session to give an overview of the training path (for SPOC and "2M-POC"),
- dedicated and personalized follow-up with participants to help some of them finish the content (all types),
- live afterwork session for our students or online afterwork session for the professionals using a specific online software (metaverse) to make the training more social,
- online Q&A sessions before the webinar that improve interactions between learners and experts (SPOC),
- regular "motivational" sessions to share some tips to "learn online" efficiently (SPOC),
- dedicated communication kit to support and motivate the teachers/students, company/learners all along the deployment period (SPOC and "2M-POC").

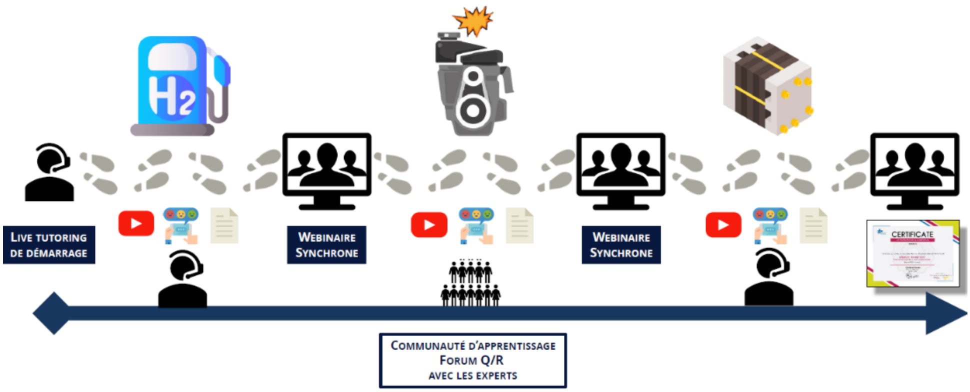

Figure 2: Training path example of a multimodal third MOOC generation

6 Conclusion

Since the beginning of MOOC production, it was difficult to propose a model that answers simultaneously the need of students, in school and universities, and the need of company's employees in a sustainable economical way. The COVID-19 crisis has clearly accelerated the demand of digital training from the industry sector. IFP School has taken this opportunity to propose a third generation of MOOCs with a new format called "2M-POC". This third generation of online training is based on a multimodal approach with a short, cost-efficient format, produced only on demand from at least one of the stakeholders of our "virtuous circle".

The results of the six "2M-POC" modules realized for three of our industrial partners are really encouraging with the following conclusions:

- a real interest for this approach from different companies all over the world,
- several tests have been done, with similar results, on different cohorts of learners from 100 (SPOC type) to 2500 (MOOC type) employees,
- a completion rate from 80 % to 96 % – total enrolled –,
- a high level of participation in webinars proposed all along the MOOC,
- a complete integration in the IFPEN ecosystem.

Finally, this third generation of "2M-POC" offers, for the first time, a real sustainable business model which allows us to continue to develop future training experiences for IFP School students and industrial partners; considering the global economic balance of the project.

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A Taxonomy of Video Genres as a Scaffolding Strategy for Video Making in Education

Magnus Nohr and Halvdan Haugsbakken

Østfold University College
B R A Veien 4, 1757 Halden, Norway
Magnus.Nohr@hiof.no | Halvdan.Haugsbakken@hiof.no

This research paper aims to introduce a novel practitioner-oriented and research-based taxonomy of video genres. This taxonomy can serve as a scaffolding strategy to support educators throughout the entire educational system in creating videos for pedagogical purposes. A taxonomy of video genres is essential as videos are highly valued resources among learners. Although the use of videos in education has been extensively researched and well-documented in systematic research reviews, gaps remain in the literature. Predominantly, researchers employ sophisticated quantitative methods and similar approaches to measure the performance of videos. This trend has led to the emergence of a strong learning analytics research tradition with its embedded literature. This body of research includes analysis of performance of videos in online courses such as Massive Open Online Courses (MOOCs). Surprisingly, this same literature is limited in terms of research outlining approaches to designing and creating educational videos, which applies to both video-based learning and online courses. This issue results in a knowledge gap, highlighting the need for developing pedagogical tools and strategies for video making. These can be found in frameworks, guidelines, and taxonomies, which can serve as scaffolding strategies. In contrast, there appears to be very few frameworks available for designing and creating videos for pedagogical purposes, apart from a few well-known frameworks. In this regard, this research paper proposes a novel taxonomy of video genres that educators can utilize when creating videos intended for use in either video-based learning environments or online courses. To create this taxonomy, a large number of videos from online courses were collected and analyzed using a mixed-method research design approach.

1 Introduction

Although there is an immense amount of systematic and rigorous research reviewing the educational use of videos, a contradiction can be identified in the research literature. On the one hand, these reviews document various usage patterns and estimate impacts on learning outcomes (e.g. [3, 25, 26]. On the other hand, there appear to be few practice-oriented frameworks, guidelines, and taxonomies for video making, with the exception of certain well-known frameworks. A leading example is the work of Mayer and colleagues [21, 22, 23], which provides pedagogical guidelines for the professional production of multimedia learning content. Contrastingly, there are few taxonomies that attempt to categorize and systematize the various shapes and forms that a video can take in video-based learning. These could serve as the basis for a novel framework that educators can use to create educational videos.

In this regard, the goal of this research paper is to propose a novel taxonomy of video genres for educators to use in creating educational videos. This taxonomy was developed through the analysis and categorization of a dataset from online teacher training courses. To explain this taxonomy, a research approach will be employed that begins with asking the following research questions (RQ):

- RQ1: *By measuring videos from a dataset of online courses used in teacher training, how can we characterize their design and usage?*
- RQ2: *What different video genres can be distinguished?*

To detail the specifics of the taxonomy, this will be done across the paper's various sections. The first part provides an overview of a relevant research horizon, followed by a detailed discussion of the methods and the taxonomy itself. The final sections will discuss the taxonomy further and conclude the analysis.

2 Research perspective

To make the case that the taxonomy of video genres can serve as a scaffolding strategy for creating educational videos, it is crucial to define a research perspective. This involves identifying relevant research literature that this paper intends to engage with and contribute to. Additionally, it is necessary to explain how specific core concepts used in the analysis of scaffolding within education, as well as selected research trends in video-based learning and online courses, or Massive Open Online Courses (MOOCs), are related to the proposed taxonomy. Given this, it becomes important to clarify what is meant by 'genre' and how it is defined, as there is a diversity of views among scholars when it comes to classifying media texts into different categories. For example, some scholars may argue that genre is a beneficial tool for distinguishing between various media texts, while others may question the value of classification systems altogether. Despite this, a genre can be defined as a type of communication with socially agreed-upon conventions that evolve over time [12], a definition adopted in this paper, it and forms an important basis for building the taxonomy. Taking these factors into account not only delineates the scope but also provides further justification for employing this approach, specifically, the approach of using video genre in video making of educational videos.

The underpinning pedagogical thinking of the proposed taxonomy aims to establish a connection with a relevant learning theory, specifically that of socio-cultural learning theory. Within this theory, Vygotsky's (1978) concept of the Zone of Proximal Development (ZPD) and scaffolding are intrinsically linked [32, 9, 35]. These concepts significantly contribute to the understanding of cognitive development and learning processes, emphasizing the role that social interaction plays in these processes. In essence, the ZPD describes the disparity between what a learner can do unassisted and what they can achieve with guidance. Scaffolding serves as a teaching strategy that facilitates learners' progression within their ZPD by providing them with successive levels of support, thereby enabling them to reach a higher level of understanding and skills. Essentially, scaffolding is an instructional strategy that offers learners the support necessary to complete tasks they might struggle with independently. This support is gradually withdrawn as the learner acquires new knowledge, hones their skills, and builds the confidence necessary for independent work. In the realm of educational research, nonetheless, there is a long-standing tradition of developing frameworks and taxonomies, including but not limited to TPACK [24], Bloom's taxonomy [1], and DigCompEdu [27]. These frameworks are formulated for numerous reasons. One is that they can articulate and express the current ontologies and social epistemologies of something that may be rather ambiguous, providing a clear structure to these entities and their embedded knowledge systems [33]. In a sense, they rationalize and break down knowledge and skills into smaller meaningful components. Thus, they have the ability to deconstruct and define complex pedagogical concepts, such as digital competence, making them more accessible and easier to apply for practitioners. In a way, frameworks and taxonomies can function as tools or strategies to reduce ambiguity in situations of significant uncertainty or complexity, providing structure and guidance for easier task performance. In other words, one could argue that the purpose of a framework or taxonomy is to conceptualize a structure that can serve as a supportive guide for constructing something meaningful and useful, thus, having the potential to serve a purpose similar to that of scaffolding strategies.

In a similar vein, the proposed taxonomy of video genres can serve a purpose akin to the scaffolding strategy. The rationale for this is primarily related to the complexity of creating videos for educational purposes, a process where educators often face many challenges. These challenges can manifest in various ways, such as not knowing where to begin, or how to design, create, and produce videos. Furthermore, designing and producing for various learning environments, such as flipped classrooms, hybrid education, and asynchronous online courses, may pose even greater challenges. In other words, it is a demanding craft to master in practice, which raises the need for developing practitioner-based support structures. Conversely, in video-based learning, one finds various frameworks that can be utilized. A notable example is the pivotal research work of Mayer and colleagues [21, 22, 23], who have laid down the foundation for designing intricate classification systems. Mayer, for instance, has suggested twelve learning design principles for the production of learning media content that are rooted in cognitive learning theory, many of which are applied when creating educational videos. Koumi (2015) [16]attempted to operationalize Mayer's learning design principles but placed a greater emphasis on a socio-cultural learning theory approach. In fact, Koumi proposed as many as 34 different techniques that educators can use to enhance learning in videos. But, a great disadvantage is that Mayer and Koumi focus on specific components in videos, such as the composition of a frame and the placement of objects within a frame. This raises the question of whether their guidelines are practical for the general educator looking to learn and incorporate video into their teaching practices, as they indeed develop into complex frameworks that contradict their purpose – instead of helping, they can be too complex to understand and use in practice. Considering that, one might question the need for other guidelines, suggesting that the taxonomy of video genres could serve as a fresh alternative.

That being said, it is essential to connect the proposed taxonomy to a relevant research stream, which is related to research on the use of videos in MOOCs. This research literature appears to approach the field from two different perspectives. Firstly, one research stream measures video performance, mapping user patterns and learner engagement, meaning that a strong learning analytic research approach has emerged. For instance, Guo et al. (2014) [14] found that different video styles yield varying learning outcomes based on perceived use. Their analysis of a data sample from 6.9 million video sessions concluded that shorter videos and those with instructor involvement were more accepted than traditional video lecturing formats. Similarly, Mamgain et al. (2015) [20] conducted a survey asking about various video features embedded in Coursera and edX. Their study revealed that learners favored short videos over in-built video-quiz features. Other studies establish that learners tend to watch videos at faster speeds. For instance, Kim et al. (2014) [15]examined data on where learners stop watching videos. Their analysis of click-level interaction (playing, pausing, and quitting patterns) indicated that long videos and tutorials are less preferred. Brinton and colleagues (2016; 2015) [8, 7] applied clickstream data from video-watching to build algorithms that can predict learner behavior. This could potentially lay the foundation for customizing assignments and assessments in new ways. Recent studies provide additional insights, showing that learners engage with videos in more complex ways than before. For example, Li et al. (2015) [19] collected data on learners watching video lectures and found that learners create new video user patterns. These are matched to personal learning strategies and the perceived difficulty of the learning content. Bonafini et al. (2017) [5] completed a study where they found that video watching and participation in discussion forums increase the likelihood of course completion. In addition, there is a trend towards making videos more interactive by embedding quizzes within them, as studied by Kovacs (2016) [17]. Kovacs' findings suggest that learners engage more deeply with in-built video quizzes, demonstrating that users who begin watching a video are likely to participate in a subsequent in-built video quiz. Furthermore, researchers have begun to employ eye-tracking technologies. Sharma and colleagues (2014, 2015) [31, 30] used this technology to demonstrate that varying gaze patterns influence student attention, thus impacting engagement. They found that learners who watch videos and engage with other learners simultaneously have better learning outcomes than students who only engage with the video material.

Secondly, there is a stream of research that has analyzed various pedagogical video styles of recorded lectures used in MOOCs. This approach aligns with, and has inspired, the development of the proposed taxonomy of video genres [2]. The research stream describes an interesting overall picture, and is more focused on understanding the meaning and purpose of how educational videos are made than measuring their performance. Although the 'talking head' video style is common in MOOCs, however, researchers have begun to refine their understanding of the recorded lecture. Early studies suggested that the simple lecture recording was not the most dominant video style and could be divided into smaller segments. For example, [14] classified six types of instructional videos used in MOOCs: (1) classroom lecture with instructor on the blackboard; (2) talking head of instructor at desk; (3) digital drawing board (Khan-style); (4) slide presentation; (5) studio without audience; and (6) computer coding session. Over time, the range of lecture-centric video styles has expanded. Rahim and Shamsudin (2019) [28]conducted an insightful study on video lectures and identified over fifteen different design approaches. Accordingly, researchers propose new ways to conceptualize videos. Some studies argue that it is more meaningful to categorize videos as either speaker-centric (a visible person delivering the content) or board-centric (content displayed on a large rectangular surface). These styles are also preferred by learners [18, 29]. Furthermore, researchers are moving from merely categorizing video styles towards developing taxonomies of videos. They are more interested in establishing their dimensional value, determined by human presence and the type of instructional media [10]. However, what seems to be missing from this emerging research stream are taxonomies of video genres that are based on pedagogical communication and the intent of the video.

One of the main reasons for drawing inspiration from pedagogical video styles as described above and relating them to the proposed taxonomy, however, is to build upon the current research, which is viewed as valuable and insightful. Another reason pertains to the context sensitivity of pedagogical video styles and their alignment with how educational videos are typically used by educators for teaching and learning. In other words, these pedagogical video styles may be more meaningful and applicable to educators, given their familiarity with how videos are used in various teaching practices. This aligns very well with Vygotsky's (1978) sociocultural theory, suggesting that pedagogical video styles are more resonant with the social and cultural learning contexts of educators [32]. Moreover, the advantage of pedagogical video styles, or video genres, is their familiarity, which could potentially reduce the ambiguity and complexity of video making, thereby creating conditions to broader acceptance of the proposed framework. By tailoring the taxonomy to these aspects, it could potentially become easier to enact scaffolding strategies, thus better supporting educators in making of educational videos.

3 Methods

To develop the proposed taxonomy of video genres, an initial research design was devised. It is crucial to explain this design because the taxonomy is primarily based on research, building upon previous studies on video production in online courses. For this investigation, a mixed-method research approach was adopted [11]. Quantitative research strategies were first used to create a dataset, which was gathered from videos from online courses at a university college. In contrast, qualitative research strategies were employed to interpret the videos and develop the foundation for the taxonomy. The research process can be divided into three distinct phases.

Firstly, the process began with a review of relevant literature, with the aim of identifying existing frameworks for the educational use of video that could serve as the basis for developing the taxonomy. Although various frameworks were found, they were either too complex or did not address specific needs, such as a simplified framework of video genres that could be used as scaffolding strategies for video creation. It is important to note that the development of the taxonomy did not start entirely from scratch. In fact, a couple of the video genres were derived from previous research conducted by one of the authors of this paper [13]. However, for various reasons, it was determined that these genres did not fully encompass the range of possibilities for creating educational videos, which are indeed numerous. Consequently, further development was necessary.

Secondly, quantitative research strategies were primarily used as a foundation and inspiration for expanding the taxonomy, which involved creating a large dataset of educational videos. As mentioned, the dataset was constructed by gathering and collating videos from online courses offered at a teacher training program at a university college. The data collection period took place in 2021. All videos from the online courses, including both self-produced and embedded videos, were scrutinized. Self-produced videos are those created by the course instructors, while embedded videos are produced by third parties and incorporated into the overall learning design for pedagogical purposes. In other words, embedded videos typically consist of YouTube videos.

Following the creation of the dataset, a straightforward coding strategy was implemented, which involved categorizing the diverse range of educational videos into initial codes that would later evolve into video genres. During the application of this coding strategy, specific criteria were used. All videos were categorized into codes based on their properties, pedagogical purposes, mediating artifacts, and the specific actions depicted in the videos. For instance, if an instructor demonstrated a particular action or activity, the video would be categorized under the "demonstration" genre. Conversely, if an educator explained a concept or if the pedagogical activity involved knowledge transfer (similar to "talking head" videos), the video would be tagged as an "instructional video" genre. This coding process laid the groundwork for further refinement of the taxonomy.

Third, the next step involved employing qualitative research strategies, primarily focusing on data analysis to further map out the potential details of the video genres. Based on the rough drafts of the videos from the dataset, the researchers developed a preliminary outline that could form the basis of the taxonomy. Naturally, this required further refinement, and was achieved through an ongoing data analysis process that involved interpreting and reflecting on the codes. These codes gradually evolved into themes that eventually became the video genres. To carry out this work, the research team utilized a data analysis strategy as outlined by [6]. They suggest applying a hermeneutical approach, which involves a cycle of interpretation, where the researcher moves from understanding the parts to the whole and back again, in an attempt to gain a deeper understanding of the context and the meaning behind the text or phenomenon. Additionally, the researchers presented a rough draft to other experts engaged in video-based education, both within and outside the university college. These experts provided valuable feedback, which was instrumental in revising and refining the taxonomy. A simplified representation of this process is displayed in Figure 1.

Figure 1: Coding process for creating video genres

4 Data analysis

In this section, the details of the taxonomy of video genres are presented. This is achieved by answering the two research questions (RQs) introduced at the outset of the research paper, which were formulated as follows: RQ1: By analyzing videos from a dataset of online courses used in teacher training, how can we characterize their design and usage? RQ2: What different video genres can be distinguished? The subsequent analysis is divided into two sections. The first part involves explaining and examining the dataset from three online courses. In second section, ten different video genres are presented, which forms the foundation for the taxonomy.

4.1 Presentation of overall data set

The process of creating the taxonomy of video genres began with an exploration of how the authors of this research paper had been developing online courses over several years, and the role that video creation played as part of their online teaching practice. At their place of employment, Østfold University College in

Norway, the teacher training department has been offering asynchronous online courses to teacher students and working teachers for several years. These courses are inspired by and developed using MOOC pedagogies and approaches, implying that openness, scalability, and flexibility are vital to their course design. The online courses cover various topics related to the digitalization of education, such as a basic introduction to ICT, pedagogical use of ICT, professional digital competence, fundamental programming, online teaching, and online course production. It is evident that videos play a significant role in the university college's asynchronous online courses, with the majority being produced by the teacher trainers themselves.

In the start of the data analysis, three asynchronous online courses completed in 2021 were selected. For analytical purposes, these are referred to as ICTMOOC, ICTPEDMOOC, and OnlineEDUMOOC. A comprehensive overview of all the videos from these online courses was compiled into a dataset, resulting in a total of 1,271 videos. Given that it is a common practice for teacher trainers to create their own videos for the online courses they teach, an analytical distinction was made between self-produced and embedded videos. Self-produced videos refer to those created by the teacher trainers, while embedded videos are those produced by others and incorporated into the online courses for pedagogical purposes. The total number of videos, as well as the breakdown for each online course, is displayed in Table 1.

Table 1: Overview of three online courses categorized into self-made and embedded videos.

Video production	**ICTMOOC**	**ICTPED-MOOC**	**Online-eduMOOC**	**Total videos**	**Total in percent**
Self-made videos	306	240	279	825	65
Embedded videos	104	131	211	446	35
Total videos	410	371	490	1271	

In the second phase of the analysis, the dataset of 1,271 videos was divided and categorized into ten video genres. This categorization and division was based on a set of criteria outlined in the methodology section of the paper.

Upon examining the percentages of videos that can be categorized into various genres, some interesting statistics emerged. These figures are displayed in Table 2. For instance, 46.5 percent of the videos can be classified as "How-To-Do" videos, while 18.2 percent are considered "Instructional/Teaching videos". The "Introduction video" genre accounts for 5.7 percent, followed by "Interview videos" making

Table 2: Overview of videos divided by genre

Video genre	ICTMOOC	%	ICTPEDMOOC	%	OnlineeduMOOC	%	Total videos	Total in pe
1 How-to-do-tutorial/demonstration	270	65,9	151	40,7	161	32,9	582	46,5
2 Instructional/teaching video	44	10,7	80	21,6	108	22,0	232	18,1
3 Introduction video	19	4,6	15	4,0	41	8,4	75	5,7
4 Interview video	19	4,6	60	16,2	74	15,1	153	12,0
5 Video on location	2	0,5	2	0,5	10	2,0	14	1,0
6 Recording in video meeting	11	2,7	1	0,3	4	0,8	16	1,3
7 Streaming/conference recording	10	2,4	4	1,1	7	1,4	21	1,6
8 Animation / Virtual Reality	15	3,7	25	6,7	37	7,6	77	6,0
9 (Self)reflection video	1	0,2	1	0,3	4	0,8	6	0,4
10 Professional video recordings	19	4,6	32	8,6	44	9,0	95	7,4
Total	410	100	371	100	490	100	1271	100

up 12 percent of the dataset. The difference in video genre utilization among the three online courses can also be observed. For example, in the ICTMOOC, the usage of the video genre “How-to-do-tutorials/demonstration” is significantly higher than in the other online courses. This higher percentage can be attributed to the nature of the ICTMOOC course, which is an introductory course in the use of various digital technologies and software, necessitating a tool-focused approach and a need for videos explaining how these tools work. In other words, tutorials are evidently required for instructional and pedagogical purposes. Conversely, in online courses that emphasize the pedagogical use of digital technologies and stress online pedagogy, like ICTPEDMOOC and OnlineEDUMOOC, the “Instructional/Teaching video” genre is more prevalent.

4.2 Presentation of a taxonomy for video genres

In this section, ten video genres are presented. An overview of the video genres is displayed in Figure 2.

Genre 1: How-to-do tutorials/demonstration
The “How-to-do tutorials/demonstration” genre involves videos where knowledge about a specific task is transferred from the tutor to the learner as an integral part of the learning process. This genre bears similarities to YouTube tutorials and often replaces the use of written manuals that may be too complex to navigate. The underlying premise of such videos is that the tutor possesses extensive knowledge about a range of digital tools and can break down and explain how to locate and utilize specific features. A sizable portion of the videos in the dataset fall under

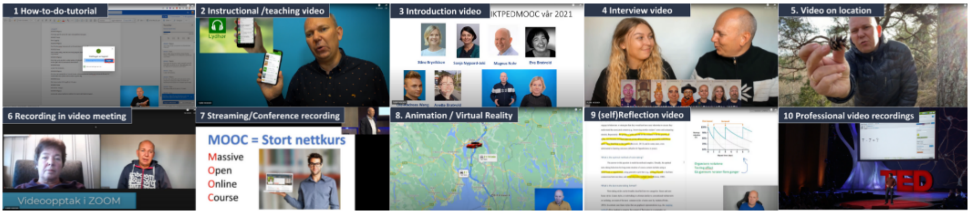

Figure 2: Overview of videos divided by genre

this genre. "How-to-do" tutorials are used to train teacher students to develop digital skills needed in their teaching practice, including the use of various digital tools, software, and resources. Typically, these videos have a narrative structure and learning goal; the tutor provides a detailed, step-by-step explanation of how to use a digital resource, simultaneously enabling the learner to apply it. The videos can be produced using screen recordings (like showing how to use a feature in software) or demonstrations of how to perform a task (such as setting up lights in a home studio).

Genre 2: Instructional/teaching videos
"Instructional/Teaching videos" is a genre where the educator either transfers or disseminates knowledge to the learner. This genre is used to explain core definitions and concepts, and it also appears in the dataset. The genre effectively substitutes the educator at the front of a classroom with one on the screen, sharing similarities with the typical "talking head" video. However, it is crucial to stress that the understanding of this genre has a broader application. A unique property of this video genre, it is argued, is that the educator disseminates, interprets, and simplifies academic or textbook knowledge, making it easier for the learner to understand the learning material. The dissemination of knowledge can occur in various ways, including lecture recordings, talking head videos, screencast recordings, image narration, greenscreen usage, and more.

Genre 3: Introduction video
The "Introduction Video" is a genre that primarily aims to familiarize the learner with topics that will be addressed later in the learning process. Introduction videos can also be employed for administrative purposes. The main characteristic of this genre, however, is to convey essential information to the learner. This information could pertain to learning content, activities, or assignments. A common example is module introduction videos, which are widely used in the three online courses. Other examples of introduction videos might include information about online

courses, lectures, portraits (of researchers/lecturers), or promotional material for study programs.

Genre 4: Interview video
An "Interview Video" is a genre that emulates the format of an interview. An interview is a structured conversation involving two or more individuals with distinct roles: the interviewer, who asks questions, and the interviewee, who responds. In the context of online courses, however, the use of interview videos often involves soliciting the opinion of an expert. Many interview videos feature a traditional interview setting, where the educator (interviewer) poses a question and the expert provides an explanation in response. The primary purpose of the video is to acquire the interviewee's perspective on a specific topic. This genre is employed to present diverse viewpoints within the online courses. Possible interviewees can range from colleagues, academics, experts, guest lecturers, conference participants, and keynote speakers, to authors of research articles and professional practitioners.

Genre 5: Video on location
The "Video on Location" genre refers to videos that shift the educator or learning experience away from traditional locations typically associated with video-based learning, such as lecture halls or studios. This genre is employed when the learning objective is to demonstrate or visualize a topic, concept, or other element that might be inadequately explained or depicted through words, text, and images found in textbooks. In other words, this genre is used to present real-world scenarios and practices to the learner. This particular video genre is not widely utilized in the three online courses examined.

Genre 6: Recording of video meeting
The "Recording of Video Meeting" is a genre primarily defined by its technical properties, typically employed to record learning activities such as teaching, supervision, and group discussions. This genre has been included due to its widespread use during the Covid-19 pandemic, when recording video meetings became a widespread practice. Recording a learning session is straightforward and requires minimal technical skills, indicating that this genre may have a valid purpose. Additionally, recorded learning sessions have become highly valued among learners. For instance, recorded Zoom sessions have gained popularity in asynchronous learning, providing learners with the flexibility to watch at their convenience. Recorded video meetings can also be used to initiate other learning activities; they can serve as documentation, showcases, or discussion starters. They can also be used for repetition or to support collaborative learning processes.

Genre 7: Streaming/conference recording
The "Streaming/Conference Recording" genre emphasizes the synchronous and asynchronous properties of video, particularly aspects related to the ongoing delivery and consumption of multimedia learning content, with the added feature of storage. This genre is of interest as it is increasingly common for educators to conduct live transmissions, either of lectures or conferences. Streaming/conference recordings can also serve a similar purpose as the sixth video genre, facilitating knowledge transfer and group discussions among learners.

Genre 8: Animation / Virtual Reality
The "Animation/Virtual Reality" genre demonstrates how techniques of photography, drawings, models, and alternative perceptions of reality can be utilized in video-based learning. This genre emphasizes that the affordances of digital technologies can be employed to demonstrate and visualize core definitions and key concepts that might otherwise be limited by modalities like text. For instance, animation can be used to create alternative presentations of core topics; artificial intelligence technologies like deepfake video can generate "avatar teachers" in online courses, and 360-degree video can offer more comprehensive experiences of real-life scenarios. However, the production of such videos is time-consuming and requires practical and technical skills, as well as the use of potentially expensive software and hardware.

Genre 9: (Self) Reflection video
The "(Self) Reflection Video" genre emphasizes the idea that educators and students can utilize reflective capabilities for knowledge creation. This genre is based on the premise that reflection is a powerful tool for learning. It enables educators and students to use retrospection to comprehend the pedagogical choices they have made, rather than merely describing their actions. In essence, in reflection videos, students or educators record their reflections and relate them to personal knowledge or skills, thereby exercising meta-cognition. Reflection videos can also be used to understand other learners' perspectives on a given topic and can be integrated into the learning design of an online course.

Genre 10: Professional video recordings
"Professional Video Recordings" refer to a genre where the educator collaborates with professional video producers. In essence, these videos exhibit exceptionally high production quality and typically require substantial resources for production, including competence, planning, time, and funding. In many instances, educators may not have access to such resources. Examples of professional video recordings include informational films, commercials, public instructional films, Ted Talks, documentaries, television productions, etc. Animation could also be categorized under this genre, as it often requires professional skills for production. The research

team deliberated whether this genre should be removed from the taxonomy and included under other genres. However, the decision was made to retain "Professional Video" as a separate genre.

5 Discussion

The aim of this research paper is to introduce a taxonomy of video genres that can serve as a scaffolding strategy, assisting educators in the complex task of creating educational videos. Essentially, the taxonomy is designed to provide a supportive structure that encourages educators to begin producing educational videos and offers guidance throughout the process. However, it is important to note that this taxonomy is not exhaustive and naturally invites further discussion. Like any taxonomy or framework, it is likely to be contested due to its inherent element of classification and boundary-setting in a widely used modality among learners. One potential criticism might be the limitation to only ten video genres; surely, there must be others? Indeed, the ten suggested video genres only emerged due to the constraints of the dataset used. Other genres, such as the video case, could certainly exist. The "video case" genre, closely linked to case-based learning, can ground education in practical applications, especially in practice-oriented fields. It enables students to connect theory with societal context, facilitating a shift from passive to active learning through real-life scenarios. The relevance created can increase student motivation for learning, and the content of video cases can prepare students for the realities of their future workplaces. Other proposed video genres may need to be merged or split due to their similarity or difference. For instance, the genres "Recording of Video Meeting" and "Streaming/Conference Recording" may be more effectively addressed as one due to their overlap. The "Animation/Virtual Reality" genre could potentially be split into two distinct genres. Moreover, each proposed video genre could also have subsections. In short, there are many possibilities to consider and be aware of, which means that the taxonomy is by no means conclusive.

Another motivation for introducing the taxonomy of video genres concerns the authors' experiences regarding the role of video making in the complex task of designing and creating online courses or MOOCs. The authors of this research paper have produced and operated several online courses covering various topics and subjects, including but not limited to introduction to ICT, pedagogical use of digital technologies, professional digital competence, online pedagogy and teaching, and online course production. These online courses are offered to teachers in schools, educators in higher education, and individuals who work with training in work life. The students take the courses because they wish to enhance their digital competencies. While the authors' online courses are research-based, they also conduct research on them. A question that emerges from this research is how they design online courses and what their core characteristics might be. The authors contend that their online courses are generally built on four pillars: text, video, assignments, and quizzes, although they acknowledge that there might be additional ones. The process of creating these courses frequently utilizes the concept of "backwards design", as advocated by Wiggins and McTighe (2005) [34]. Their instructional design process begins by identifying what the students are expected to learn. Following this, they select the appropriate learning materials, activities, and assessment methods. A critical question in this design process is deciding the most suitable modality to deliver the learning materials and structure the learner's experience. Often, during the design process, one can quickly gravitate towards "video" as a way to deliver the learning material to students, but this can pose challenges. For example, educators new to video making may start producing many videos, but when they compile these and set up a digital learning environment, it can create a passive learning experience that simply replaces the traditional lecture. However, effective use of video for professional practitioners in education is indeed a complex task, something that is often only fully understood in retrospect. This raises the pertinent question: How can students, who are professional practitioners or teachers, be taught to design and create videos suitable for their practice? In response to this, the authors propose the taxonomy of ten distinct video genres as a starting point for this conversation.

There might be substantial justification for such a statement. In traditional classroom teaching, a plethora of research and diverse pedagogical directions are available to aid teachers in selecting teaching methods that enhance the teaching and learning process. Constructive alignment [4] and understanding by design [34] serve as notable examples. That being said, there is also a need for a similar discussion concerning effective teaching practices when utilizing video in education. During the COVID-19 pandemic, for example, many educators were forced to make a quick transition to online teaching with little time or no adequate training. The authors argue that this lack of time and expertise may have resulted in numerous unrefined pedagogical choices, particularly in the usage of video for online teaching. Many educators embraced video-based learning, but due to a lack of skills and personal competence, the effective use of video proved challenging. This raises the crucial question: when will the education system empower future teachers to make pedagogical choices that enhance their ability to use videos in a manner that fosters learning? The authors contend that educators and students require tangible guidelines or frameworks to aid them in making appropriate pedagogical choices when using video. This need arises, in part, due to a lack of awareness about the various methods and possibilities in video production. Therefore, a framework that supports teachers' understanding of video production is indeed necessary. One approach among many is to provide a taxonomy of video genres, which can serve as a guiding structure, or be applied as part of a general scaffolding strategy.

The justification for a taxonomy of video genres becomes more apparent when considering the frameworks available. For instance, Mayer and colleagues' influential work [21, 22, 23] has significantly impacted the design of multimedia learning content. Mayer's research is centered around understanding specific aspects of multimedia learning contents, focusing on the brain's capabilities to process intricate details in video frames. However, creating high-quality videos that align with Mayer's outlined learning principles necessitates access to professional video production facilities and TV studios – resources often inaccessible to many professional practitioners. Another researcher who expands on Mayer's cognitive theory is Koumi (2015) [16]. Across several papers, Koumi has presented a taxonomy of 34 pedagogic video design principles for video production. Koumi convincingly presents a set of tools that could be used by video producers for pedagogical communication. While Koumi and Mayer's work is essential when creating effective teaching videos, the authors of this paper believe their tools may be too complex for professional practitioners to integrate into practical teaching routines. In other words, there is a need for more abridged and practical frameworks.

Such frameworks can potentially be found in recent research on the use of videos in MOOCs. For instance, Chorianopoulos (2018) [10] has outlined an intriguing taxonomy of various asynchronous instructional video styles, which is akin to the taxonomy of video genres proposed in this paper. Chorianopoulos advocates for a focus on video formats rather than production styles, a viewpoint the authors agree with. In doing so, Chorianopoulos provides various examples, emphasizing that video format or style classification should be determined according to the degree of human presence and type of instructional media. In essence, the type of video format is determined by how centered the video is on the board and the human. The authors of this paper acknowledge the significant work done by Chorianopoulos in developing this taxonomy and were inspired to outline their own. They adopted a genre approach, positing it to be more useful and meaningful, as it enables the capture of the pedagogical communication mediated in the video. Focusing on communication conventions may provide a more suitable and accessible tool to support educators in their use of videos in professional practice.

6 Conclusion

The Covid-19 pandemic led to a dramatic increase in the use of educational videos in both schools and academia. This surge in video usage prompts a need to benchmark good practices and define minimum quality criteria for effective educational videos. The evolution of educational videos began with on-campus lecture recordings and has since expanded into various exciting and multifaceted directions, particularly within online and blended education. Perhaps it is now time to develop research-based frameworks for video, a feasible long-term goal. Existing frameworks such as TPACK [24] and DigCompEdu [27] provide digital competence guidelines for teachers. So, why shouldn't there be one for the use of videos in learning and education? To understand and assess quality, a common framework is necessary. The research-based taxonomy of video genres proposed in this paper might represent a starting point for conceptualizing such a framework. Its utility could lie in providing educators with an overview of possible genres for educational videos, thereby assisting in their pedagogical decision-making process.

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Instructional Design for Work-Based Skill MOOCs

Challenges for Workforce Development in Thailand

Jintavee Khlaisang[1,2], Vorasuang Duangchinda[2,3], Thapanee Thammetar[2,4], and Anuchai Theeraroungchaisri[1,2]

[1] Chulalongkorn University
[2] Thailand Cyber University project (TCU), Ministry of Higher Education, Science, Research and Innovation, Thailand
[3] Sripatum University
[4] Slipakorn University

As Thailand moves towards becoming an innovation-driven economy, the need for human capital development has become crucial. Work-based skill MOOCs, offered on Thai MOOC, a national digital learning platform launched by Thailand Cyber University Project, ministry of Higher Education, Science, Research and Innovation, provide an effective way to overcome this challenge. This paper discusses the challenges faced in designing an instruction for work-based skill MOOCs that can serve as a foundation model for many more to come. The instructional design of work-based skill courses in Thai MOOC involves four simple steps, including course selection, learning from accredited providers, course requirements completion, and certification of acquired skills. The development of such courses is ongoing at the higher education level, vocational level, and pre-university level, which serve as a foundation model for many more work-based skill MOOC that will be offered on Thai MOOC soon. The instructional design of work-based skills courses should focus on the development of currently demanded professional competencies and skills, increasing the efficiency of work in the organization, creativity, and happiness in life that meets the human resources needs of industries in the 4.0 economy era in Thailand. This paper aims to present the challenges of designing instruction for work-based skill MOOCs and suggests effective ways to design instruction to enhance workforce development in Thailand.

1 Introduction

As Thailand evolves into an innovation-driven economy, the incorporation of work-oriented skill courses is catalyzing transformative changes. For instance, the Elderly

Care MOOC and a range of other skill-based MOOCs are tackling inherent educational challenges, thereby steering Thailand towards an enlightened future. The escalating popularity of MOOCs stems from their flexibility and accessibility, facilitated by both foreign platforms and indigenous university platforms, notwithstanding the issues of cost, accessibility, and language barrier. Thai MOOC, a government-led initiative through the Thailand Cyber University Project under the Ministry of Higher Education Science Research and Innovation, stands out for its distinctiveness. Offering a plethora of courses in the Thai language and ensuring cost-free education for all, Thai MOOC has become a beacon of strength, boasting a robust enrollment of 1,641,672 students as of 25 April 2023. (https://thaicyberu.go.th) With the demographic shift towards an aging society, the demand for elderly caregivers is on the rise. This need is recognized by the Thailand Cyber University (TCU), which is fostering an elderly care workforce and ensuring accessible knowledge in this realm via the open system of Thai MOOC [6, 3].

Thai MOOC, developed by the Thailand Cyber University Project (TCU) under the Ministry of Higher Education, Science, Research, and Innovation (MHESI), has launched a pilot project in academic cooperation with Sukhothai Thammathirat Open University, the Institute of Community Colleges, and Thailand Professional Qualification Institute. Together, they create ability courses while Thai MOOC serves as a coordinator and supports relationships with other MOOCs in developing quality courses by combining knowledge from similar courses from partner organizations [1].

The 420-hour Advanced Caregiver Curriculum for the Elderly was meticulously crafted with the aim of universal accessibility, delivering flexibility in time and location, and catering to the unique needs of the elderly. The curriculum is bifurcated into two components: The first part, a Massive Open Online Course (MOOC), comprises 104 hours of theoretical instruction and 96 hours of practical exercises, aggregating to 200 hours spread across seven subjects. The second part necessitates 110 hours of on-site practice in a healthcare facility and an equal number of hours in community service, summing up to 220 hours. The practical training is tiered into three levels: basic, intermediate, and advanced, encompassed in three courses titled Elderly Care I, II, and III.

The curriculum is thus designed to improve elderly care, to empower individuals of all ages to explore learning opportunities, enhance employability, foster lifelong learning, and generate career avenues. Its shared learning objectives are geared towards equipping learners with the ability to identify, evaluate, and manage age-associated diseases. This innovative curriculum addresses societal shifts necessitating long-term healthcare for the elderly, aligning with the World Health Organization's (WHO) Decade of Healthy Aging (2020–2030). At the national level, it influences policies, plans, and various departments, such as the 2nd National Plan on the Elderly (2002–2021), The 20-year Strategic Plan (2018–2037), and initiatives for elderly physical and mental well-being by The Ministry of Social Development and Human Security [8].

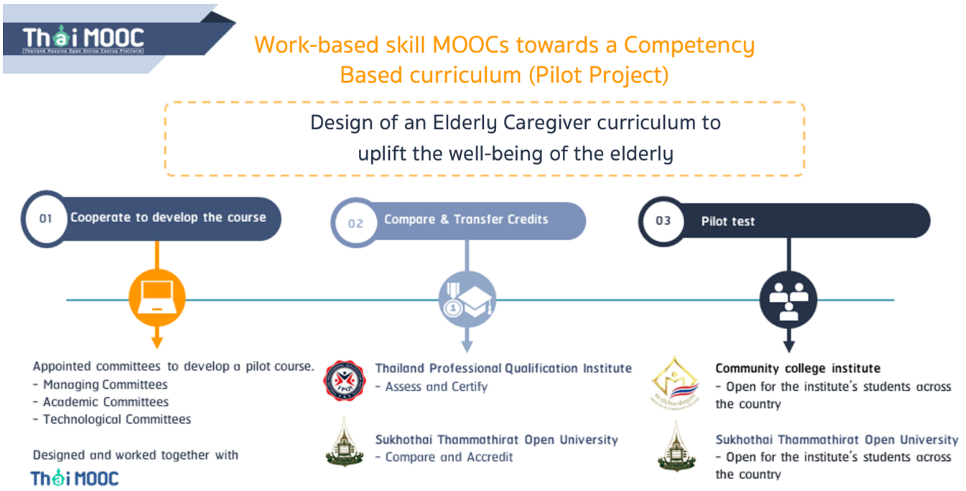

Figure 1: The 420-hour Advanced Caregiver Curriculum for the Elderly https://thaicyberu.go.th

Thai MOOC is also working on an open system for grade transferring of online courses to accord with international standards and expand opportunities for people to access higher education, creating a broader learning society and promoting lifelong learning [2]. By mid-2023, Thai MOOC will offer even more work-based courses, utilizing the experience gained from offering the elderly care program as a foundation for further developments [5].

2 Work-based skill MOOC

Work-based skill courses offered via Thai MOOC are in line with the objectives of Thailand's 20-year national strategy, designed to foster proficient human resources, cater to the nation's requirements, and enhance global competitiveness. This vision necessitates significant investments in human capital, equipping them with knowledge and skills that align with professional and personal life demands. This would facilitate the development of expertise in their chosen fields and meet the

Figure 2: Thai MOOC Categories

country's imperative for global competitiveness [4]. In the context of Thailand, Thai MOOC plays a crucial role, as it collaborates with over 120 educational institutions, including domestic and international public and private organizations. It has made significant strides by offering more than 500 online courses, with a special emphasis on work-based skill MOOCs, thereby extending its services to a broad audience [9]. This collaborative effort ensures the sustainability of both the courses and the platform. The work-based skill courses are a product of the wealth of experience and knowledge amassed by Thai MOOC and its partners. They also serve as foundational elements for the development of additional work-based skill courses in the future, facilitating the continued growth of Thai MOOC and the Thai education sector at large.

Apart from the aforementioned pilot project, three new developments of similar courses at higher education, vocational, and pre-university levels are underway. Leveraging two of the national strategies, namely developing Thai people of all ages in all dimensions and developing high-performance human resources [7], these work-based skill MOOCs are being crafted. These projects lay the foundation for an array of future work-based skill MOOC slated to be offered on Thai MOOC. These developments include:

1. Development of permanent personnel working in Seafarers with King Mongkut's University of Technology Thonburi (KMUTT) MOOCs.

2. Development of vocational workforce in Digital Business with Office of Vocational Education Commission (OVEC) MOOCs.

3. Development of workforces in Modern Trade Business Management with Panyapiwat Institute of Management (PIM) MOOCs.

These projects aim to equip learners with the necessary knowledge, skills, and abilities to excel in their respective fields, fostering a competitive workforce that meets the country's needs and contributes to global competitiveness. As the need for human resources continues to grow, individuals must possess complex problem-solving abilities, analytical thinking, creativity, effective communication, and collaboration skills. In the age of data, the ability to analyze data is of critical importance. Thai MOOC's work-based skills courses are appropriate tools for developing these human resources, providing Thai people with convenient and equal access to education [10].

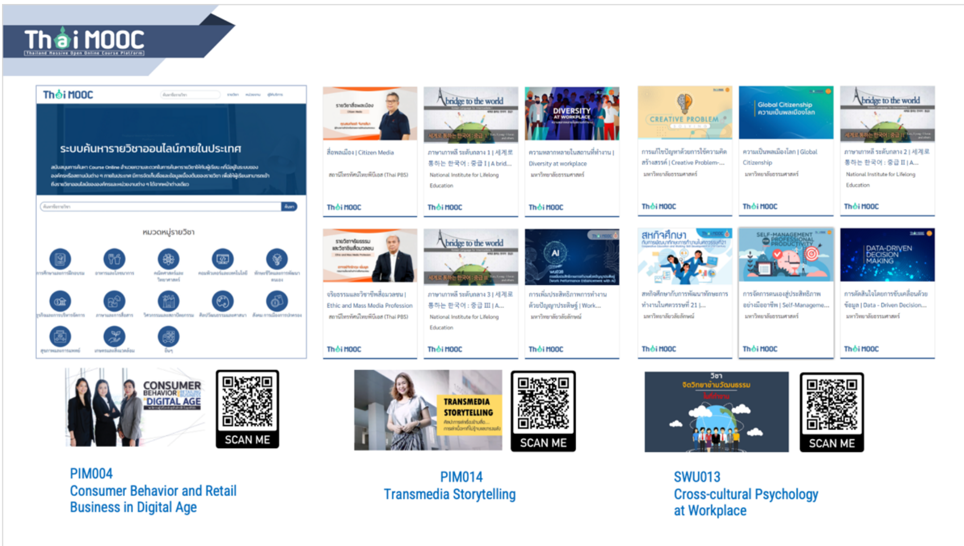

Figure 3: Courses for Upskills and Reskills

As Thailand faces various challenges in its transition towards an innovation-driven economy, the introduction of work-based skill courses, including the Elderly Care MOOC and other work-based MOOCs, is a significant step towards addressing these challenges and shaping a brighter future for its citizens. Thai

MOOC and work-based skills courses provide an effective way to overcome educational hurdles and ensure that the country's education system leads the way for all Thai citizens, fostering lifelong learning and promoting a highly skilled workforce capable of competing on a global scale.

3 Conclusion

In conclusion, Thai MOOC has made significant strides in expanding its services and promoting lifelong learning to enhance human development in Thailand. This progress aligns with the goals of the 13th National Economic and Social Development Plan, addressing the challenges faced by the country as it transitions to an innovation-driven economy. By introducing work-based skill courses such as the Elderly Caregiven MOOC and other similar programs, an effective solution emerges to overcome educational barriers, ensuring equitable access to education for all Thai citizens.

These courses not only focus on developing professional competencies and skills currently in demand but also aim to enhance work efficiency, promote creativity, and foster a happy living. The collaboration between various institutions, such as the MHESI, ICC, TPQI, OVEC, and MOE, has strengthened lifelong learning in the country, enabling Thai MOOC to serve as the digital learning platform for achieving these goals.

As Thailand continues to invest in human resources and provide individuals with the knowledge and skills necessary for success in their professional fields, the country is well-positioned to build global competitiveness and foster a sustainable learning society. Thai MOOC, with its expanding range of work-based skills courses and partnerships, will continue to play a pivotal role in driving innovation, progress, and lifelong learning for Thai citizens in the years to come.

Acknowledgment

This paper is part of the Thai MOOC (Thai Massive Open Online Course) project, a national digital learning platform, which is a flagship project officially launched by Thailand Cyber University (TCU), Ministry of Higher Education, Science, Research and Innovation, Thailand.

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Innovat MOOC

Teacher Training on Educational Innovation in Higher Education

Carlos Alario Hoyos[1], Carlos Delgado Kloos[1], Doris Kiendl[2], and Liliya Terzieva[3]

[1] Dept. Telematic Engineering, Universidad Carlos III de Madrid
Avenida de la Universidad 30, E-28911 Leganés (Madrid), Spain
[2] International Management Institute, FH Joanneum University of Applied Sciences
Eggenberger Allee 11, Graz, Austria
[3] The Hague University of Applied Sciences
Johanna Westerdijkplein 75, 2521 EN Den Haag, The Netherlands
calario@it.uc3m.es

The COVID-19 pandemic has revealed the importance for university teachers to have adequate pedagogical and technological competences to cope with the various possible educational scenarios (face-to-face, online, hybrid, etc.), making use of appropriate active learning methodologies and supporting technologies to foster a more effective learning environment. In this context, the *InnovaT* project has been an important initiative to support the development of pedagogical and technological competences of university teachers in Latin America through several trainings aiming to promote teacher innovation. These trainings combined synchronous online training through webinars and workshops with asynchronous online training through the MOOC "Innovative Teaching in Higher Education." This MOOC was released twice. The first run took place right during the lockdown of 2020, when Latin American teachers needed urgent training to move to emergency remote teaching overnight. The second run took place in 2022 with the return to face-to-face teaching and the implementation of hybrid educational models. This article shares the results of the design of the MOOC considering the constraints derived from the lockdowns applied in each country, the lessons learned from the delivery of such a MOOC to Latin American university teachers, and the results of the two runs of the MOOC.

1 Introduction

The COVID-19 pandemic forced many educational institutions to move to the so-called emergency remote teaching [16] overnight due to the social distancing restrictions imposed by the different countries [9]. This major shift presented three types of challenges [4]: (a) technological challenges, such as the lack of devices and internet connection in the case of some teachers and students; (b) social challenges, such as the lack of appropriate space at home for teachers to teach online and for students to attend online classes and study; and (c) pedagogical challenges, such as the lack of digital competences of some teachers to teach their classes online, the need to urgently generate complementary interactive multimedia materials for learners, or the difficulties to adapt the assessment system to the lack of physical presence.

The lack of digital competences of teachers [13] was an issue that many universities had to address urgently due to COVID-19. The presence or absence of teachers' digital competences plays an important role both in students' level of learning and in the development of these digital competences by students [8]. In Europe, the European Framework for the Digital Competence of Educators (DigCompEdu) was already published before the pandemic as a self-perception diagnostic tool to measure teachers' digital competences [11]. Nonetheless, its adoption to make decisions about the training needs of teachers accelerated in the wake of the pandemic. In the case, for example, of Latin America, there is no single framework for measuring teachers' digital competences. In some cases, the UNESCO ICT Competency Framework for Teachers [15] or the above mentioned DigCompEdu framework [11] are used as a reference. In addition, it is important to note that the level of digital competences of Latin American university teachers varies greatly between countries and even within the same country, and that this is a topic that has been hardly addressed in the literature [14].

In this context emerges InnovaT [10], a capacity building in the field of higher education project co-funded by the Erasmus+ Programme of the European Union, aimed at fostering innovation in teaching and learning in Latin America, with a special focus on Peru and Chile but with an expected impact on the whole region. This project was designed before the pandemic but was implemented mainly during the pandemic, requiring the adaptation of activities initially planned in a face-to-face format to an online format. Three main training actions were carried out in the project after this adaptation [10]: (1) a series of online webinars, (2) the MOOC "Innovative Teaching in Higher Education", and (3) a series of online exploratory workshops. The three training activities were carried out sequentially, using the output of each activity as input to the next one. This article focuses on the MOOC, sharing the results of designing and running it twice, the first one during the lockdowns applied to most countries in 2020, presenting some of the main lessons learned, and the results obtained.

2 Innovative teaching in higher education

The MOOC "Innovative Teaching in Higher Education" was designed in collaboration between the three European universities involved in the InnovaT project, FH Joanneum University of Applied Sciences (FHJ) in Austria, Breda University of Applied Sciences (BUas) in the Netherlands, and Universidad Carlos III de Madrid (UC3M) in Spain. This MOOC had six modules (weeks): (1) "How to be an innovative teacher"; (2) "Design thinking, co-creation, and innovative games"; (3) "Exposition"; (4) "Interaction"; (5) "Project-based learning"; and (6) "Innovative assessment systems and portfolios". The first two modules were designed by BUas, the following two by UC3M, and the last two by FHJ. The overall workload of the MOOC was equivalent to 1 ECTS (weekly students' workload of approximately 5 hours). The MOOC was intensive in audio-visual content with 70 short videos with the core content, plus weekly wrap-up videos, as well as infographics and additional reading materials [1]. The MOOC was also intensive in exercises with more than 100 formative assessment activities plus summative assessment activities [1]. These summative assessment activities included quizzes and a peer-assessment activity with the purpose to design an innovative syllabus using the knowledge and skills gained in the MOOC. 60 points out of 100 were required to pass the MOOC. The MOOC was offered in Spanish. Some videos were recorded in English but included Spanish subtitles. All exercises and complementary activities were in Spanish. The MOOC was deployed on edX Edge, an auxiliary platform hosted and maintained by edX, with functionality equivalent to that of edX, and used by many universities in the edX consortium to deliver some of their MOOCs, especially when they are in a pilot phase.

The MOOC began to be designed at the beginning of 2020, although this design was affected by the pandemic. More specifically, the MOOC had to be reformulated in response to the need to strengthen the pedagogical and technological competences of Latin American university teachers due to the fast transition to emergency remote teaching that took place in March 2020. Meetings were organized with the Latin American universities participating in the project (three from Peru and three from Chile), involving them in the design of the MOOC. The results of the series of online webinars that took place in May 2020, which replaced the face-to-face training activities planned for that time, were also considered in the design of the MOOC.

The biggest difficulties encountered during the design of the MOOC and the creation of the contents were mainly related to the strict lockdowns undergone in Europe in spring 2020. Firstly, the lack of experience in MOOCs by several of the European partners led to the need for frequent online meetings (replacing scheduled onsite meetings) to try to align the course content and structure. Secondly, the additional overload on university teachers resulting from the quick transition to emergency remote teaching led to the need to reorganize the planned schedule for the MOOC. For example, challenges were experienced with the times to translate the subtitles of videos recorded in English into Spanish as well as with the translation of other materials. Thirdly, the closure of the universities prevented the recording of videos for the MOOC in the facilities of the universities, requiring the recording of videos from home in some cases, or waiting until the universities reopened in some other cases. These difficulties were successfully resolved with increased coordination and the willingness of the project partners to cooperate.

The MOOC was released twice. The first run took place between June 16th and July 30th 2020 [5] (during the pandemic). The second run took place between June 14th and July 31st 2022 [6] (after the pandemic). The contents of the second edition of the MOOC were revised based on the results obtained in the first edition, adjusting both videos and exercises.

3 Results

The two runs of the MOOC had a total of 2340 registered participants (see Table 1); 408 (17.4 %) of them received the certificate for having passed the course. This percentage is higher than the usual completion rates for this type of courses [12]. It is worth noting a higher number of registered participants and certificates issued in the first run, possibly due to the lockdown period in Latin America and the high demand for training on the topic of the MOOC at this time.

Table 1: Number of registered participants and certificates issued in the two runs of the MOOC. The gender of the participants who received a certificate is also indicated

	Registered participants	Certificates issued	
First run (2020)	1339	236 (17.6 %)	138 (female), 97 (male), 1 (other)
Second run (2022)	1001	172 (17.2 %)	75 (female), 90 (male), 2 (other), 5 (not reported)
TOTAL	**2340**	**408 (17.4 %)**	**213 (female), 187 (male), 3 (other), 5 (not reported)**

Teachers from 24 countries registered in the first run of the MOOC, mainly from Latin American countries, with Peru (66.8 %) and Chile (22.7 %) leading the ranking [2]. This was mainly due to the dissemination efforts made by the Latin American partners of the *InnovaT* project (all of them from Peru and Chile) with their teachers and with other teachers from other higher education institutions in their own countries. Teachers from ten countries registered in the second run of the MOOC, once again mainly from Latin American countries, but this time with Colombia (50.1 %), Peru (19.9 %), Chile (18.4 %), Ecuador (5.4 %), and Honduras (4 %) leading the ranking. This second time the dissemination efforts went beyond the countries of the *InnovaT* consortium, taking advantage of other existing Latin American networks, such as the PROF-XXI network [7], for promotion purposes.

A survey was used for the evaluation of the quality of MOOC. This survey was completed by the participants at the end of the course, so the results have the usual positive bias of data collected through surveys in this type of courses since students who drop out of the course do not give their opinion on the course. This survey was completed by 394 participants from 15 countries considering the two runs of the MOOC (236 in the first run and 158 in the second run) [3]. Peru (46.4 %), Chile (27.7 %) and Colombia (17.8 %) were the countries with the highest numbers of respondents. Table 2 shows the participants' ratings of the quality and usefulness of the content presented in the MOOC for each of the six modules (scale from one to five). The results show a very positive rating both on quality and usefulness of the content. This is true for each of the two runs of the MOOC and in aggregate.

Table 2: Assessment by MOOC participants of the quality of the content and usefulness of the content per module (scale from one minimum to five maximum)

	Quality of the content	Usefulness of the content
Module 1	4.48 (SD=0.74)	4.58 (SD=0.68)
Module 2	4.53 (SD=0.73)	4.6 (SD=0.68)
Module 3	4.75 (SD=0.5)	4.72 (SD=0.55)
Module 4	4.76 (SD=0.48)	4.79 (SD=0.49)
Module 5	4.75 (SD=0.51)	4.72 (SD=0.55)
Module 6	4.41 (SD=0.78)	4.54 (SD=0.74)
TOTAL	1 (SD=0.65)	66 (SD=0.63)

Regarding the organization of the MOOC, 93.7 % of the respondents indicated that the navigation through the home page of the course was easy or very easy (on a scale of five levels – very difficult, difficult, neutral, easy, very easy). Similarly, 94.4 %

of the respondents indicated that the navigation through the different modules of the course was easy or very easy. Positive results were also obtained when assessing the individual components of the course, with 95.7 % of the respondents considering the use of the videos easy or very easy, 88.1 % of them considering the use of assessment activities easy or very easy, 70.8 % of them considering the use of the peer assessment activity easy or very easy, and 82.2 % of them considering the use of the forum easy or very easy. These results were obtained although most of the participants had no experience with the platform in which the MOOC was offered. Finally, 99.5 % of the respondents indicated that they would recommend this MOOC.

4 Lessons Learned

The data collected from participants' responses to the final survey lead us to pose ten lessons learned from the design and running of this MOOC, although some of these could be extrapolated to equivalent situations: (1) *calculate accurately student workload*, especially when the MOOC is implemented as a collaboration among several institutions (some students complained in the first run of the MOOC that the workload was way higher than the originally estimated 1 ECTS); (2) *be sensitive to deadlines*, especially in exceptional situations such as those derived from a disaster situation like a worldwide pandemic (the additional workload resulting from the lockdown and transition to emergency remote teaching meant that many teachers participating in the MOOC needed some extra time to complete the summative assessment activities scheduled in the MOOC); (3) *be careful with translations*, especially if the MOOC is aimed at a target group that may have low or medium English proficiency (this requires extra planning and effort to be thorough with the translation, in the case of this course from English to Spanish in some modules) (4) *do not neglect summative assessment activities*, especially try to avoid rote questions or fill-in-the-blanks questions that expect a very specific concept as the answer (poorly designed summative assessment activities may strongly disengage participants); (5) *be aware of the different backgrounds in participants*, especially in a transversal course such as this one aimed at university teachers coming from different areas of knowledge (this requires approaching examples and practical exercises from several angles); (6) *seek the right level of depth in explanations*, especially on those topics that may be of greater interest to the target audience (the last module on innovative assessment systems and portfolios was on a very high demand at the time this MOOC was released for the first time); (7) *take special care of participant engagement*, especially in the more passive part of the course like videos (this requires, for example, carefully planning the scripts of the videos so that these follow best practices, like an adequate duration); (8) *identify clearly core content and complementary content*, especially if the students' workload in the MOOC is expected to be high (this requires proper indications and guidance to the students so that they can better organize their time spent in the MOOC); (9) *handle the notifications sent to students properly*, especially in the case of latecomers who might have missed previous communication from instructors (this demands allocating a visible space in the course to published all the previous notifications sent); and (10) *explain in detail the summative peer assessment activities*, especially if your target audience is not familiar with this type of activity (this activity demands greater complexity, coordination and attention to deadlines).

5 Conclusions

This article presents a successful case of the MOOC Educational Innovation in Higher Education, designed from Europe by experts in the field but destined to be consumed at a different region, in this case Latin America. This MOOC is a representative example for several reasons. First, it is a MOOC that arrived just in time, at the very moment when teachers most needed training to cope with the rapid transition to emergency remote teaching derived from the COVID-19 pandemic. Secondly, it is a MOOC that yielded very positive data, both in terms of number of registered participants (2340) and certificates issued (17.4 %), as well as in terms of the quality and usefulness of the contents provided. In fact, the assessment of the quality and usefulness of the contents provided has been very positive in all the six modules of the MOOC, which covered related but complementary topics. Thirdly, this MOOC is an example of an international collaboration between European instructors of multidisciplinary backgrounds who coordinated to offer this course, and Latin American institutions that contributed to promoting this course among their teachers and among other teachers in the region.

It is important to keep in mind that the first run of the MOOC was part of a more ambitious and innovative training program that combined online webinars (prior to the MOOC) and online exploratory workshops (after the MOOC). This training program was adapted from its original conception to the constraints of the COVID-19 pandemic and still could have a meaningful impact on Latin American teachers. Moreover, the MOOC could run for a second edition at the request of Latin American institutions. This second run also served to improve some aspects detected after the first run and takes into account the ten lessons learned identified in this article.

Acknowledgment

This work was supported in part by grant PID2020-112584RB-C31 funded by MCIN/AEI/10.13039/501100011033, in part by the Madrid Regional Government through the e-Madrid-CM Project under Grant S2018/TCS-4307, and in part by European Commission through Erasmus+ Capacity Building in the Field of Higher Education project InnovaT (598758-EPP-1-2018-1-AT-EPPKA2-CBHE-JP). This publication reflects the views only of the authors and funders cannot be held responsible for any use which may be made of the information contained therein. We would also like to thank all partner universities in the *InnovaT* Project for their work in relation to the MOOC "Innovative Teaching in Higher Education": UACH, USACH, UVM, ULIMA, UDEP, UCSP, FHJ, BUAS, and UC3M.

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An Experience in Developing Models to Use MOOCs in Teaching and to Advocate OERs

Francesca Concia[1], Petr Distler[2], Gareth Law[3], Elena Macerata[1], Mario Mariani[1], Eros Mossini[1], Maddalena Negrin[1], and Marko Štrok[4]

[1] Politecnico di Milano
francesca.concia@polimi.it | elena.macerata@polimi.it | mario.mariani@polimi.it | eros.mossini@polimi.it | maddalena.negrin@polimi.it

[2] Czech Technical University in Prague
petr.distler@fjfi.cvut.cz

[3] University of Helsinki
gareth.law@helsinki.fi

[4] Jožef Stefan Institute Ljubljana
marko.strok@ijs.si

Loss of expertise in the fields of Nuclear- and Radio-Chemistry (NRC) is problematic at a scientific and social level. This has been addressed by developing a MOOC, in order to let students in scientific matters discover all the benefits of NRC to society and improving their awareness of this discipline. The MOOC "Essential Radiochemistry for Society" includes current societal challenges related to health, clean and sustainable energy for safety and quality of food and agriculture.

NRC teachers belonging to CINCH network were invited to use the MOOC in their teaching, according to various usage models: on the basis of these different experiences, some usage patterns were designed, describing context characteristics (number and age of students, course), activities' scheduling and organization, results and students' feedback, with the aim of encouraging the use of MOOCs in university teaching, as an opportunity for both lecturers and students. These models were the basis of a "toolkit for teachers". By experiencing digital teaching resources created by different lecturers, CINCH teachers took a first meaningful step towards understanding the worth of Open Educational Resources (OER) and the importance of their creation, adoption and sharing for knowledge progress. In this paper, the entire path from MOOC concept to MOOC different usage models, to awareness-raising regarding OER is traced in conceptual stages.

1 Introduction

In this article, the authors aim to provide an account of the process that took place from the development of a Massive Online Open Course (MOOC) under an international partnership with funding from Horizon 2020 to the creation of different patterns for presenting the MOOC to students.

The article also discusses the use of "external" educational resources as essential for innovation of teaching practices. The authors share their reflections on the use of the MOOC in various ways by different teachers and students, and the challenges they encountered in integrating it into their teaching practices.

Through this article, they hope to shed light on the potential benefits of using MOOCs and Open Educational Resources (OER) in education and encourage teachers to explore these resources for their courses.

2 "Essential Radioc-Chemistry for Society"

2.1 A first motivation: loss of scientific expertise

Expertise in Nuclear- and Radio-Chemistry (NRC) is crucial not only in the nuclear industry, but in several vital applications for modern society [3]. This expertise is fundamental for facing the challenging issues related to safe nuclear power plant operation, their future decommissioning, and nuclear waste management, but also for assuring several NRC applications in non-energy fields. Progress achieved in diagnostics and therapy within nuclear medicine is one of the most meaningful examples of how society could benefit from continuous enhancement in scientific knowledge within NRC. Similarly, other fields, such as radiation protection and radioecology, nuclear forensics and safeguards operations, as well as dating techniques for geology and archaeology, are all based on NRC knowledge.

Given the broad scope of applications and the strategic importance of NRC expertise, it is essential to promote and enhance education and training in this field. The development of educational resources such as MOOCs and OERs can play a significant role in this regard, by providing accessible, flexible, and high-quality learning opportunities for students and professionals around the world. Despite its relevance, NRC is not widely taught in high schools and universities [10]. It is perceived as being a non-modern field of chemistry, and even where available, it is not among the most selected subjects. Several studies reported on the lack of perceived relevance as the main reason for low interest in science study and career [13, 7]. In addition, younger generations perceive these disciplines related to radioactivity and in general to nuclear industry as something to be afraid of.

Consequently, in recent years, the availability of few engaging curricula and few career prospects in NRC, along with a misperception of this subject and a low awareness of its relevance, is causing a serious lack of interest among younger generations and consequently of NRC expertise in many parts of the world [6, 2]. Indeed, the missed turnover in knowhow due to retirements of the skilled workforce, and decreases in recruitment of newcomers, is leading to a serious skills shortage in NRC expertise.

2.2 Proposed solution: a MOOC to spark interest in students

In response to the NRC skills shortage and low uptake of students to NRC courses in higher education, a Massive Open Online Course has been selected as an educational approach to achieve three main goals: i) increasing students' awareness about the relevance of a controversial and specialized discipline such as NRC, ii) clarifying fears and misconceptions about anything related to "nuclear" and iii) increasing the number of students in NRC programs and related careers [5, 9].

A MOOC can be easily adapted to spread knowledge on different topics by addressing different target groups and going into the required level of detail. Additionally, a MOOC is open and available online, providing the ability to reach large numbers of students worldwide.

The MOOC titled "Essential Radiochemistry for Society" was designed and made within the H2020 MEET-CINCH project[5] through the collaboration of 12 partners from nine European countries, including universities, research institutions and partners from industry [4].

MOOC design started from a careful analysis of target audience and context in order to develop a completely online learning path aimed at achieving effective awareness and durable knowledge. The main target group was identified as being students already pursuing scientific studies: in chemistry first, but also physics, biology, nuclear medicine and engineering. Taking into consideration the prerequisites and time needed to acquire a basic comprehension of such a difficult discipline, bachelor students were selected. General didactical goals and the learning objectives were consequently identified to address the target needs [8].

Organization of topics within the MOOC followed a logic of application areas: Radiochemistry "for the environment", "for health", "for industry", "for nuclear energy", and "for society", so that it was easier for users to understand why NRC is useful with respect to the fields in which it is applied, highlighting the consequences of each application in terms of advantages and disadvantages.

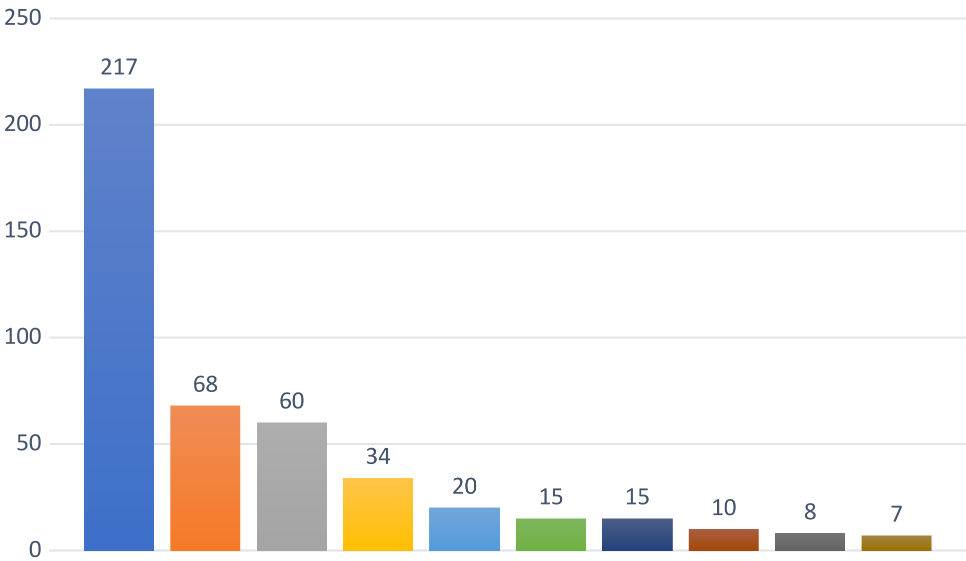
[5] https://www.cinch-project.eu/meet-cinch/

The whole course consists of 152 lessons, comprising 52 videos, 23 infographics, 34 exercises and 33 articles, and the estimated effort to complete it is about 30 hours[6].

2.3 Data collection and analysis

Currently (March 2023) 663 users have enrolled on the MOOC since it was made available in June 2020.

Figure 1: User numbers, per country, for the "Essential Radiochemistry for Society" MOOC



2.4 First edition (pilot, 2020)

203 users (57 women, 75 men, 71 not declared) took part in the first edition of the MOOC. The users were mainly 20 to 25-year-old students studying in scientific areas, from 24 different countries all around the world. The main origin countries

[6]The MOOC "Essential Radiochemistry for Society" is available on Polimi Open Knowledge Platform http://www.pok.polimi.it/.

for the students were Italy (65), Slovenia (38), and Germany (10); 25 % of users completed the course and obtained the Certificate of Accomplishment.

To assess the MOOCs effectiveness, clarity, and completeness, as well as to highlight critical aspects, a small group of students at Politecnico di Milano were asked to take part in a focus group and answer questionnaires about workload, level of knowledge acquired, interest aroused, lesson formats, difficulties encountered, contents, quizzes etc. Analysis of collected data, together with the results obtained by a focus group, enabled us to derive useful information.

Students declared to have devoted on average 4.2 to 5.3 hours to complete each MOOC "Week", judging the workload coherent with what indicated.

Similarly, requested pre-requisites were considered enough to understand the course.

A relevant percentage of students (30–50 %) stated that they gained enough knowledge to be able to explain NRC to other people, and just as many stated that they understood the main topics and were able to understand general situations related to them.

Concerning the course structure, students appreciated alternation of different lesson formats (videos, infographics, articles, link, exercises, quizzes) to explain topics, with intermediate self-assessment, and guided exercises to apply competences.

Some considerations could be done concerning the average score achieved in the final exam. It is equal to 0.91/1, supporting the effectiveness of the overall MOOC materials.

Thinking to the grades achieved, it is possible to state that modules showing a lower average grade are characterized by (i) presence of complex concepts and/or several technical details, such as the module on "Nuclear Medicine, Sterilization and Tracer technology"; (ii) few video-lessons, such as the module on "Confinement and waste management"; (iii) complex concepts presented as infographic, such as in the module on "Nuclear forensics and proliferation"; (iv) lack of practical examples; (v) presence of long articles with too many details.

Concerning the impact of the MOOC on users' personal and professional experience, data collected highlighted that interest in the topic and the level of engagement achieved are paramount to captivate users and thus to drive their future involvement.

2.5 Second edition (2020–2021)

The second edition was attended by 193 users (59 females, 84 males, 50 not declared), mainly belonging to the same target group (20 to 25-year-old students in scientific areas), with students participating from 32 different countries: 44 % from Italy, 9 % from Finland, 7 % from Slovenia, and 5 % from Kazakhstan. The percentage of users who completed the course was 19 %, with a high average score in the final exam (0.82/1).

2.6 Third edition (2021–2022)

The third edition was attended by 130 users (46 females, 56 males, 28 not declared), again mainly belonging to the target group (20 to 25-years-old students in scientific areas), and enrollees were mainly from Italy (55), and Slovenia (11), from 27 different countries.

2.7 Fourth edition (2022–2023)

The fourth edition is currently online, and thus far has been attended by 175 users, (58 females, 77 males, 40 not declared), about half mainly belonging to target group mentioned before, from 26 countries, with enrollees mainly from Italy (44), Finland (36), Czech Republic (27), and Slovenia (12).

Table 1: Numbers of enrolled users (gender, origin) to "Essential Radiochemistry for Society" MOOC for each edition

	Enrolled users	**Females**	**Males**	**Not declared**	**Origin Countries**	**Italy**	**Finland**	**Czech Republic**	**Slovenia**
First edition	**203**	57	75	71	24	65	2	6	38
Second edition	**193**	59	84	50	32	72	15	0	11
Third edition	**130**	46	56	28	27	55	8	2	11
Fourth edition	**175**	58	77	40	26	44	36	27	12
	701	**220**	**292**	**189**	**109**	**236**	**61**	**35**	**72**

Taking the case of Politecnico di Milano, we have observed a threefold increase in the enrollment of students in the Master's course for Nuclear Engineering since the launch of the MOOC. During the first edition of the MOOC, we introduced a short course for bachelor students about it. While this may be a possible reason for the significant increase in enrollment (due to the exact timing), we need to conduct a further investigation to confirm this hypothesis. If proven true, it would confirm the objective of the MOOC.

Table 2: Number of enrolled users to "Essential Radiochemistry for Society" MOOC from Politecnico di Milano

		Enrolled users	Italy	Students from POLIMI
First edition	*2020*	203	65	28
Second edition	*2020–2021*	193	72	59
Third edition	*2021–2021*	130	55	37
Fourth edition	*2022–in progress*	175	44	29
		701	**236**	**153**

3 MOOC Usage Models

With "MOOC usage models", we mean studying how lecturers in the CINCH partnership adopted the MOOC in their teaching activities, finding commonalities and differences due to: (i) context characteristics (student numbers, scheduling of classes and availability of time, possibility to have class both in presence and online); (ii) methodological choices (blended learning, flipped classroom, active learning); (iii) specific content in order to identify possible patterns.

Models created for the MOOC "Essential Radiochemistry for Society" can actually be adopted and adapted for many MOOCs and online resources in general.

MOOCs are exceptional learning resources, often created within prestigious institutions, by teachers who are passionate about their subject and wish to spread knowledge as widely as possible. "Essential Radiochemistry for Society" is a complete course, born out of an international collaboration, designed by a multidisciplinary team and reviewed by experts in each specific field of the subject, so it is an opportunity to learn more about NRC and understand all its applications.

Hence the desire that it can be used in whatever way it can be useful for learning.

3.1 A second motivation: encouraging to use the MOOC

Users enrolled in one of the four editions of "Essential Radiochemistry for Society" and used the course in very different ways: some completed the course and obtained the final certificate, while others left it after a few lessons; some users found a video on YouTube channel and looked for other videos to deepen their understanding of some unclear concepts. The variety of motivations and behaviors of individual users is beyond our ability to trace paths and understand them [11].

Therefore, we focus our inquiries on teachers' approaches. It is interesting to see how teachers belonging to the follow-on A-CINCH[7] project have adapted the use of the MOOC to their specific needs and goals for their courses. Some have used it as a complete course, while others have focused on specific topics or used it as a resource repository. This flexibility in usage shows the potential of MOOCs and other online resources in providing educators with additional tools to enhance their teaching and provide students with a variety of learning opportunities. The use of online educational resources can also contribute to a more collaborative and interconnected educational landscape, where educators can share and adapt materials to better serve their students.

3.2 Proposed solution: a kit for teachers

As we encountered resistance from some teachers to adopt 'external' teaching resources within their courses, we investigated the reasons for this opposition. While some of the answers are not easily addressed, others, such as (i) lack of time for redesigning the didactic activities of the course, (ii) distrust of online tools, and (iii) lack of trust in content created by experts from other countries with slightly different programs can be addressed. Our solution is a kit with mapped paths and steps that can be followed. The "Essential Radiochemistry for Society" kit for teachers describes MOOC content, structure and possible usage patterns, along with the peculiarities of application cases in project partners universities.

3.3 Model 1: MOOC and MORE

The first model to be experienced and drawn was called "MOOC and MORE" and is addressed to university students in scientific areas and structured in four main learning activities:

- Self-paced learning: study of the MOOC "Essential Radiochemistry for Society".
- Self-reflection about own effective knowledge of learnt topics: responding to questionnaires investigating difficulty in understanding contents, interest aroused by certain topics and the best didactical solutions.

[7] https://www.cinch-project.eu/

- Teamwork: designing a science communication event for general public.
- Peer-review and collaborative discussion: presenting project works and discussing it with teachers and other participants.

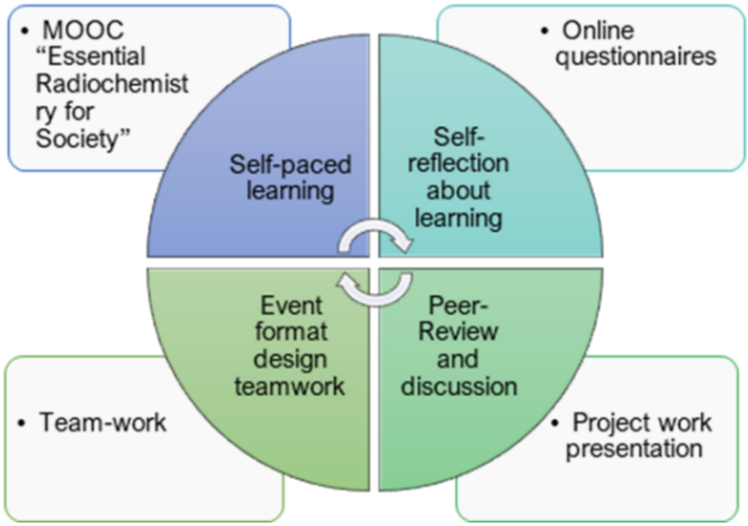


Figure 2: "MOOC and More" Model

According to this usage model, MOOCs are a starting point to learn about the main topics of the discipline: students have to study all lessons and pass all quizzes, but it is also the subject of meta-cognition, since the students have to design a dissemination event about the MOOC's topics.

MOOC and MORE have been tested at Politecnico di Milano in the framework of "Passion in action", an extracurricular initiative open to all students, and at the Jožef Stefan International Postgraduate School in the postgraduate course "Tools for environmental quality control" that is part of the PhD Program Ecotechnology during the lectures slot devoted to radiochemistry for the first year PhD students enrolled in the course.

Table 3: Comparison of two experiences at a glance

	"Passion in action" at Politecnico di Milano	**"Tools for environmental quality control" at the J. Stefan International Postgraduate School**
Target group	Bachelor's degree students in scientific areas, who are interested to enrich their personal and professional experience by deepening Nuclear- and Radiochemistry	PhD students in scientific areas, who are interested to enrich their personal and professional experience by deepening Nuclear- and Radiochemistry.
Knowledge entry requirements	This activity is addressed to students who have basic knowledge of mathematics, physics and chemistry	Activity is addressed to students who have basic knowledge of mathematics, physics and chemistry.
Number of participants	30	20
Learning outcomes	The participants are able to list the areas of application of Nuclear- and Radiochemistry in everyday life, to describe the results and the advantages it could introduce, to choose the topics for a general public, adapting the language for a general public.	The participants are able to list the areas of application of Nuclear- and Radiochemistry in everyday life, to describe the results and the advantages it could introduce, to choose the topics for a general public, adapting the language.
Location	University classrooms/online	University classrooms/online
Didactical tools	Online didactical materials, teamwork, peer review, role play, synchronous meetings, formative feedback	Online didactical materials, teamwork, peer review, role play, synchronous meetings, formative feedback
Technical tools	Web conference platform for online meetings, sharing of recorded meetings, online surveys, online lab tools	Web conference platform for online meetings, sharing of recorded meetings, online surveys, online lab tools
Period	holiday period	winter semester
Duration	three months	two months
Pedagogical framwork	Multi-approach and multi-tool experience	Multi-approach and multi-tool experience
Sessions	three	three
Estimated effort	30 hours	30 hours
Badge/ Certificate	Recognition of university credits: 2 ECTS (Italian CFU)	n.a.

3.4 Model 2: Flipping the MOOC

The model "Flipping the MOOC" can be used for different purposes:

- providing students with easily accessible, educationally designed, scientific resources,
- introducing different approaches to learning experiences,
- deepening the understanding of a particular theme.

The flipped classroom concept is a meta-framework that can be applied in several pedagogical perspectives. It is based on the idea that the classroom time is utilized best for interactive learning activities with teachers and peers, while activities based on content are carried out at home. The teacher selects or prepares the materials that the students study independently before and after the in-classroom activities. The "flipping" concept is linked to the idea that this approach reverses the traditional allocation of the teaching-learning activities. Typically, teachers present content in classrooms and assign memorization, systematization, retrieval and self-assessment as homework. By freeing up time in the classroom from content transfer activities, the flipped classroom approach can be applied in many situations. It is a result of the evolutionary process in the range of blended learning strategies that explore the integration between online and face-to-face learning aiming to optimize the learning advantages for both components.

The model has been tested by the University of Helsinki (UH) in the framework of an optional curricular course "Radiopharmaceutical chemistry" under the Master's Program in Chemistry and Molecular Sciences. Module 2.1 of MOOC on nuclear medicine serves as an introduction to the course.

Beyond the great variety of application, depending also on the pedagogical perspectives, the flipped classroom model can be outlined as follows:

- Study at home: the teacher presents students with a set of selected materials or ad hoc products (booklets, chapters of books, articles, videos, MOOCs). Students use them to understand (on their own) the main contents that will be topics of the following in-class lessons.
- Active learning and collaborative classroom: the teacher proposes collaborative activities intended to provide in-depth analysis and guidance to the application of previously studied contents, thus enhancing consolidation and comprehension through group dynamics.
- Consolidation at home: after the lesson, the student goes back to the classroom activity to complete it or integrate it by going over the more complex topics, before starting to prepare for the subsequent lesson.

Table 4: University of Helsinki experience at a glance

	"Radiopharmaceutical chemistry" under the Master's Program in Chemistry and Molecular Sciences at the University of Helsinki
Target group	students of age ~20 to ~55
Knowledge entry requirements	completion of the UH Chemistry Bachelor's level course on Radiochemistry, and the UH Chemistry Master's level Basic Radiochemistry exercises laboratory work class.
Number of participants	MOOC has been used by 3, 11, and 16 students in 2020, 2021, and 2022 respectively.
Topics	Basic concepts, production of radionuclides, radiosynthesis methods, production of radiopharmaceuticals, quality control, imaging, applications
Location	Since the implementation of the MOOC, the classes were onsite in 2020. The classes of 2021 and 2022 were held online.
Didactical tools	The MOOC quizzes and presence phase exercises were used to gauge the students' preliminary understanding of the subject matter and help teachers plan student progression in learning. Students engaged in discussions during the presence phase, and were divided into smaller breakout rooms where they could engage in problem solving as a team.
Technical tools	The online presence phase was carried out using Zoom. Online video lectures were available on YouTube. Online surveys were performed using the web pages of the UH. Presence phase collaborative discussion was carried out using Flinga and Google Jamboard.
Period	The activities were performed early in the UH Spring semester.
Duration	The course lasted for 2.5 months (one standard teaching period).
Pedagogical framework	The course starts with the introductory MOOC videos and quizzes followed by the presence phase. The course is offered in a flipped classroom format where each online lecture is accompanied with a presence phase. There were also lectures from external speakers and a site visit to a nuclear medicine department of a University of Helsinki hospital.
Sessions	The lectures were carried out in 20 sessions among which six of these are always online as they are recorded lectures. The rest of the lectures can be performed online or in a classroom.
Estimated effort	The overall time allocated for a course with five ECTS is 135 hours. Out of this, watching lectures and face-to-face phase accounts for approximately 40 hours.
Badge/ Certificate	none

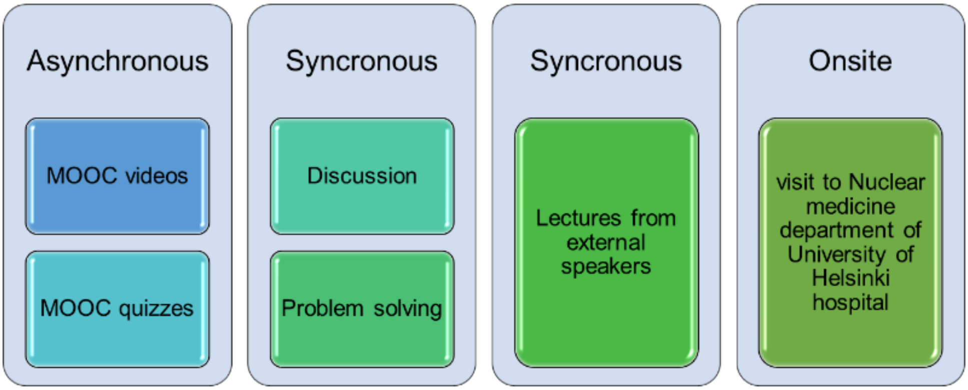


Figure 3: "Flipping the MOOC" Model

3.5 Current activities

During the last weeks new experiences have been carried out. In Czech Republic a teacher conducted two different tests: one at Czech Technical University in Prague in the class General Chemistry with 20 students of Nuclear Chemistry (mostly 19 and 20 years old) with content about decay law and the second one at Gymnázium Altis in Prague, with pupils mostly 16 to 19 years old with content about radioactivity, properties of ionizing radiation, the use of f-metals, and radiation accidents. At the University of Oslo, a team of teachers chose some specific MOOC materials to be studied by students, putting special emphasis on quizzes and assessments.

From these experiences new models will be available soon.

3.6 Results of the first experiences

Based on feedback analysis, it has become clear that the experience had a highly positive impact. Students appreciated the self-paced learning approach because it allowed them to construct their own understanding of the subject matter and offered the flexibility of an on-demand learning experience. Additionally, the presence phase was found to be necessary for building relationships and connections among students and with lecturers. When this phase was organized as a collaborative and teamworking activity aimed at problem-solving it was particularly effective. Even during the COVID-19 pandemic, the online presence phase was beneficial for students because they could engage with the course materials, maintaining relations with peers and lecturers.

Overall, these findings highlight the importance of providing students with both self-paced learning and collaborative activities to enhance their understanding and enjoyment of the course material.

4 Open Educational Resources

Massive Open Online Courses and Open Educational Resources share many characteristics: they are both available online, contribute to open education, are emerging in the context of international higher education as possible responses to the social, economic, and cultural changes of recent years. They also can be integrated into synchronous teaching and are useful sources for self-study and in-depth study. MOOCs and OER have the potential to accelerate didactical innovation processes by providing an opportunity for new kinds of collaboration between different institutions in the higher education sector, overcoming disciplinary and organizational boundaries [1].

4.1 A third motivation: promoting Open Educational Resources

One of the objectives of the A-CINCH project is to promote the use of Open Educational Resources. OER offer teachers the opportunity to reflect on their personal teaching practices, the effectiveness of their approach, the methodologies used by their colleagues, the needs and characteristics of their students, and the value of instructional design, as well as assessment methods. Such reflection is crucial for every teacher, and it can be stimulated by using and creating resources with an open license – where "open" means not just free, but also free with permissions. The link between the experience of MOOCs and OER was initially unknown to us, but became evident later. Some researchers have previously investigated the connection between them, going as far as to consider MOOCs released under an open license as a subset of OER [12].

In this article, we do not intend to take sides in this debate, but rather to highlight how the analysis of MOOC usage patterns in teaching practices has laid the groundwork for achieving a second goal: encouraging teachers to experiment with and value blending online resources created by other experts in nuclear and radiochemistry courses. Lecturers who used MOOC in their courses have appreciated the value of having easily accessible, well-structured resources, in-depth materials, and self-assessment quizzes, created by experts in the field.

Students have also appreciated the possibility of easily accessible learning material from any device and in different formats, allowing for different learning styles.

It seems that the experience of A-CINCH project is similar to that of teachers and students who use any open resource.

5 Conclusion

In this article, we have summarized the long journey that led from the concept of MOOC "Essential Radiochemistry for Society" to its production, thanks to the collaboration of experts from various European nations, up to its delivery to groups of European students. The data we report are promising in terms of the possibility that a greater number of students can enroll in a specialization related to the nuclear sector, so that knowledge in this area does not get lost over time.

We believe it is interesting to emphasize the versatility of the MOOC that we have observed in the different experiences conducted which proves the potential of MOOCs: not only a complete course, but also a pool of stand-alone and thematic resources. Moreover, the same resource used in different contexts offers truly multifaceted learning opportunities.

The encouragement to experience the use of MOOCs has triggered teachers to consider how students learn, how much study effort is required, and whether it is possible to adopt previously untried didactic approaches to achieve specific learning objectives.

This MOOC in particular, made it possible to overcome the differences (contents, approaches) existing between the curricula of European countries, offering a single and shared reference.

This experiment led us to take the first step towards another goal, not strictly related to the MOOC, namely promoting Open Educational Resources among the partners of A-CINCH project and their institutions. In fact, they had already experimented with the redesign of a course to include online resources – also thanks to the COVID-19 pandemic – and verified the flexibility of the approach and the positive impact on student engagement.

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Central Elements of Knowledge and Competence Development with MOOCs

Using the Example of the OER-MOOC

Kristina Neuböck and Nadine Linschinger

Center for Digital Teaching and Learning, University of Graz
Liebiggasse 9/II, 8010 Graz, Austria

To implement OERs at HEIs sustainably, not just technical infrastructure is required, but also well-trained staff. The University of Graz is in charge of an OER training program for university staff as part of the collaborative project Open Education Austria Advanced (OEAA) with the aim of ensuring long-term competence growth in the use and creation of OERs. The program consists of a MOOC and a guided blended learning format that was evaluated to find out which accompanying teaching and learning concepts can best facilitate targeted competence development. The evaluation of the program shows that learning videos, self-study assignments and synchronous sessions are most useful for the learning process. The results indicate that the creation of OERs is a complex process that can be undergone more effectively in the guided program.

1 Introduction

Open Educational Resources (OERs) have increasingly become a key element in the field of education in recent years. The first definition of OER dates back to 2002 [6] and has been adapted several times over the last 20 years [7]. The benefits of OERs (5 Rs – Reuse, Retain, Revise, Remix, Redistribute) [11] show that OERs are not only freely accessible and easily adaptable, but can also increase the quality of teaching materials.

In order for OERs to be implemented sustainably at HEIs, not just the technical infrastructure is required, but above all well-trained staff who have the expertise and skills for the legally secure use and creation of OERs. The University of Graz has therefore identified central pillars within its OER policy, namely support services, qualification measures and the distribution of information material [8].

In the inter-university cooperation project Open Education Austria Advanced (OEAA), the University of Graz is responsible for the development of an OER training program for university staff with the aim of ensuring lasting competence growth in the use and creation of OERs. This training program is based on two pillars. The first is the MOOC "Using and Creating OERs" (OER-MOOC) which is freely available under a CC BY 4.0 license for all interested users on the Austrian MOOC platform iMooX and aims to convey basic OER knowledge in a self-learning format. The second is a blended learning training course that was designed based on the MOOC, which focuses on the development of OER competencies with synchronous online meetings and individual support. On the basis of evaluation results collected at the University of Graz in the period from 3 March 2022 to 28 February 2023, this paper will show which accompanying teaching and learning concepts can facilitate targeted competence development with the help of a MOOC.

2 Pillar 1: The MOOC "Using and creating OERs"

The self-study course "Using and creating OER" [3] has been available free of charge since March, 3rd 2022 on www.iMooX.at and consists of four units.

Unit 1 gives an overview and introduction to Open Educational Resources. After that, participants learn how to search for and find OERs in unit 2 and are given an overview of the guidelines for creating OERs in unit 3. Finally, in unit 4, the participants are given the opportunity to plan their own OER project. Table 1 gives an overview of the structure of the MOOC.

Table 1: Design of the MOOC

Unit 1 – Introduction	**Unit 2 – Searching and finding OERs**	**Unit 3 – Creating OERs**	**Unit 4 – My OER Project**
What are OERs?	CC license models	Basic rules of OER creation	OER practice report
Experience with OERs	Sharing OERs	Combining licenses	Planning OER projects
Why use OERs?	Where to find OERs?	Legal aspects	OER practitioner
OERs and copyright	Quality of OERs	Publishing OERs	

To facilitate knowledge acquisition, four videos with corresponding transcripts are available in each unit. To accompany each video, learners receive additional materials for more in-depth reading. For better guidance on the individual learning objectives, a mascot named "KatOER the OER cat" acts as a connecting element in the MOOC and introduces the learning objectives of the videos, summarizes the central content and draws attention to any cross-references. This combination of videos, transcripts and accompanying materials provides participants with a broad foundation for targeted knowledge acquisition in the field of using and creating Open Educational Resources.

In addition to extensive (legal) knowledge, a broad range of competences is required for the correct use and high-quality creation of OERs. Assuming a constructivist view of learning, in which knowledge is acquired independently and actively in a context of action [4], targeted competence development requires "motivation-activating learning processes" [2]. According to this, successful learning processes consist of six central characteristics, including the presence of positive emotions, the self-direction of processes, the integration of new knowledge into existing knowledge patterns, the independent participation of the learner, but also the interaction with others and the acquisition of knowledge within the framework of contextual and situational references [4].

A MOOC can only partially enable these processes. For instance, forums have the potential to support interaction of learners. However, research shows that only around one third of course participants actively take part in discussions within forums [1]. Contextual references to the learning and work environments of the participants are created in the videos and through practice-oriented accompanying material. However, practical tasks and individual coaching in regards to the assignments would be more precise ways of supporting the participants individually.

3 Pillar 2: The guided training program

In order to close these gaps, we designed a guided training program on the basis of a blended learning approach to complement the MOOC's self-learning offer within the OEAA project. The aim is to provide university staff with not only basic OER knowledge, but also specific OER application skills. Alongside the independent exploration and creation of OERs, an exchange with peers and experts is central to the program. In this way, the participants can expand their personal OER knowledge and improve their OER use and creation skills.

The guided training builds on the OER-MOOC. The participants complete this course in self-learning mode. At the same time, various assignments are to be completed, which support the application of the acquired knowledge and the targeted development of competences.

During three synchronous online-meetings, the individual challenges of the practical implementation are discussed with the participants, individual perspectives for growth are identified and open questions are answered. The final step of the training is the publication of three self-produced OERs. During this process, the participants receive extensive support and feedback on the created materials from the course leader. Figure 1 gives an overview of the guided OER training with a duration of eight weeks and a workload of 25 hours / 1 ECTS credit.

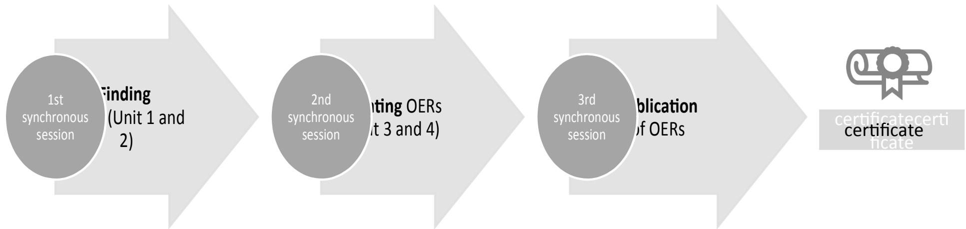

Figure 1: Process of the OER training program

By completing this training, participants achieve the following learning objectives:

- I can name and use different open licenses and their requirements and differences.
- I can find Open Educational Resources (OERs).
- I can create, revise and remix OERs.
- I can publish OERs and make them available to others.

The assessment consists of attendance at the synchronous sessions, completion of the OER-MOOC, verified by the iMooX certificate, successful completion of a total of nine assignments including revision according to the individual feedback from the course instructor, peer reviews and the correct publication of three self-created OERs.

The training is based on Schlögl [5] and the Active Blended Learning approach (ABL) by the University of Northampton [10]. This concept combines face-to-face interaction, small group teaching, problem-solving and allows to learn anywhere in the world [9]. The mix of self-learning phases, synchronous sessions, peer feedback and accompanying coaching encourages social processes and, with the help of specific tasks, draws on the individual professional experience of the course participants. This enables a targeted acquisition of knowledge and the development of basic digital skills [10] for the use and creation of OERs.

4 Knowledge and competence development

In the period from 3 March 2022 to 28 February 2023, 407 participants successfully completed the MOOC in self-study mode, which is 44 % of all registered users. The requirement for MOOC completion is the successful participation in four quizzes with 75 % correct answers. At 44 %, the MOOC completion rate is way above average (see results in [1] – completion rate 7.6 %). However, these figures are put into perspective, as the completion of the MOOC is compulsory in the context of various OER continuing education formats, as shown by numerous forum posts in the MOOC's introduction forum [3].

In the same period, 75 people participated in the guided OER training program at the university of Graz during its four runs, 72 % of whom successfully passed the training. At the end of the last synchronous session of each run, the participants were asked to take part in an online evaluation, for the purpose of continuous improvement of the training program in line with the needs of the target group, as well as for scientific monitoring of the development process. By using six question blocks and 23 individual questions, the course participants were asked about the content, the structure and the implementation of the training. Also, they were asked about their personal evaluation of the achievement of the learning objectives. Around 63 % of the participants responded to the entire online evaluation, and 76 % answered at least some of the evaluation questions.

A central element of the survey was the question of how helpful the learning methods were for achieving the learning objectives. An overview of the results is given in Figure 2. It is evident that the completion of the assignments is regarded as a very helpful tool for achieving the learning objectives by around 94 % of participants. The materials and references as well as the instructional videos are rated as very helpful by about 90 %, followed by synchronous sessions (83 %), peer reviews (71 %) and participation in the supervised forum (69 %).

The evaluation clearly shows that the completion of work assignments, the instructional videos, the materials and references and the synchronous sessions were most frequently rated as very helpful in achieving the learning objectives. The MOOC in self-learning mode, however, provides its participants with only one part of these most important factors.

The importance of guided training is also emphasized by the findings regarding the achievement of the learning objectives. As shown in Figure 3, the participants

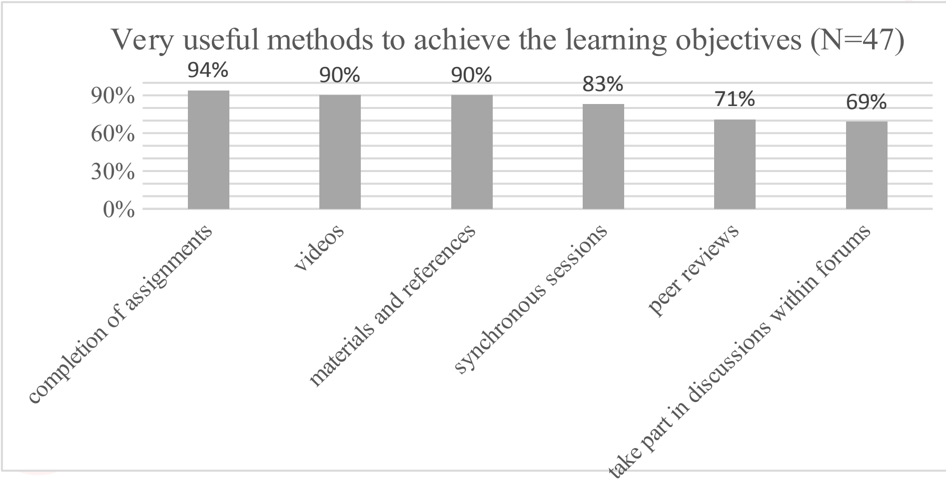

Figure 2: Usefulness of methods of learning to achieve the learning objectives

strongly agree that they have achieved the four learning objectives through the guided OER training. However, the level of agreement decreases significantly as the learning objectives become more complex.

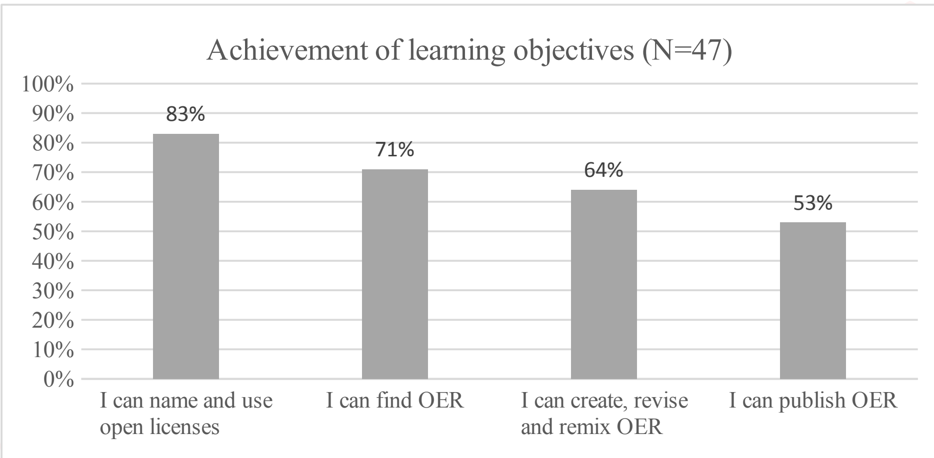

Figure 3: Achievement of learning objectives

The findings support the fact that the complexity of the topic of OER increases significantly from basic knowledge, through the use of OER, to the creation of OER, and with this the need for corresponding skills also increases. Only just over 50 % of the participants in the guided training program agreed that the learning objective for the publication of OER had been achieved. With regard to the learning objectives on basic knowledge about OER and on finding OER, almost 84 % and 71 % respectively agreed that these learning objectives had been achieved.

These results indicate that the creation of OER is a complex process that can be taught more effectively in a guided training program.

5 Conclusion

A sustainable implementation of OERs at HEIs requires a substantial training offer that provides not only basic knowledge but also expert and content-related support in the use and creation of OERs. Such support services enable sustainable competence development among university staff, which in turn has a positive impact on the quality of the materials developed.

The MOOC "Using and creating OERs" in self-learning mode is a suitable tool for presenting basic knowledge through various materials. Due to a lack of data, however, no conclusion can be drawn on whether the learning objectives have actually been achieved. The evaluation results of the guided OER training have shown, however, that the need for comprehensive teaching and learning concepts that support situational, social and self-directed learning increases with the complexity of the learning objectives.

In the future, it would be beneficial to evaluate the OER-MOOC in a more focused way in order to obtain informative data on the achievement of learning objectives through self-study courses. These data could be used to develop targeted strategies to promote knowledge and competence development for self-learning courses.

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Challenges and Proposals for Introducing Digital Certificates in Higher Education Infrastructures

Anja Lorenz, Stefanie Bock, and Juleka Schulte-Ostermann

Technische Hochschule Lübeck
Lübeck, Germany

Questions about the recognition of MOOCs within and outside higher education were already being raised in the early 2010s. Today, recognition decisions are still made more or less on a case-by-case basis. However, digital certification approaches are now emerging that could automate recognition processes. The technical development of the required machine-readable documents and infrastructures is already well advanced in some cases. The DigiCerts consortium has developed a solution based on a collective blockchain. There are ongoing and open discussions regarding the particular technology, but the institutional implementation of digital certificates raises further questions. A number of workshops have been held at the Institute for Interactive Systems at Technische Hochschule Lübeck, which have identified the need for new responsibilities for issuing certificates. It has also become clear that all members of higher education institutions need to develop skills in the use of digital certificates.

1 Introduction

Discussions about awarding credits points for MOOCs began shortly after they emerged in the early 2010s [6]. However, there was no rush to the exam offices so far. Rather, MOOCs are used for personal development. Recognizing them to study programs, on the other hand, remains complex and is often still handled on a case-by-case basis. The widely predicted opening up of universities has not yet happened. Instead, the introduction of micro-credentials opens up yet another "currency" in further education.

A crucial factor seems to be the time-consuming verification of certificates: the learning outcomes have to be compared with those of the study modules in order to decide whether the MOOC is relevant to the study program at all. If this is the case, it is also important to check that the MOOC meets the university's quality standards for content, exercises and, most important, assessments.

There are now some approaches to automate these processes. The basis for this is a standardized competence model, which can be implemented by digital certificates. In addition, the content of the certificates must be sufficiently verifiable to make it difficult to fake them. Finally, a digital infrastructure is needed on the university platforms to issue and manage the certificates. Additional services such as recognition databases or automated recommendation systems can then be established.

In section 2 of this article, current approaches and proposals from the projects of the Technische Hochschule Lübeck (TH Lübeck, https://www.th-luebeck.de/) are presented and described. The technical implementation is often well advanced and prototypical implementations are already in use. In the course of the step-by-step implementation of the infrastructure in productive learning programs, however, new questions have arisen that go beyond purely technical aspects. This paper will focus on these. These challenges and the first results of our workshops are presented in section 3 , and further steps and limitations of digital certificates are finally discussed in section 4.

2 Background: digital certificates

Initially, the development of digital certificate infrastructures focused on technical issues and solutions. The need to support also institutional implementation became apparent as the technical implementations were progressively rolled out into productive learning modules. At this point, decisions had to be made about organizational implementations that did not have established processes and solutions in place for paper certificates.

With the development of the first MOOCs in 2014 [9], we have already issued certificates of participation that can be described as *electronic certificates*. We have built our platform using the open source learning management system Moodle (https://moodle.org/), which supports rule-based certificate issuance. This creates PDFs that can be configured in terms of content and design. But these certificates are merely electronic reproductions of their paper counterparts. They lack one important feature: they are not machine-readable. As a result, they cannot be processed automatically. Students at higher education institutions in Germany have their academic achievements electronically stored and managed in a database. To this end, about 220 higher education institutions in Germany have set up a cooperative called HIS Hochschul-Informations-System eG (translated: HIS Higher Education Information System, registered cooperative), which organizes not only the academic achievements for individual modules, but also the administration of diplomas. These diplomas require further legal specifications (e.g. they have to be signed by the head of the university) and are therefore not considered further in this article.

There are three key aspects to the implementation of digital certificates:

1. An important precondition for machine-readability of certificates is a **standardized competence model**, which enables cross-platform documentation of certificate contents. For this purpose, Europass provides a practical basis [2]. Since 2004, the European Parliament and the Council have been working on this harmonized description of competences [5], which is intended to improve the interfaces between the worlds of education and work and to facilitate the international recognition of qualifications. It was updated in 2018 [4]. Within the Europass framework, XML schemas, web services and other components have been developed on which digital certificates can – and should – be based in order to achieve the intended compatibility.

2. When implementing digital certificates, the **ability to verify the data** is important. Digital documents (especially text and images) can be easily created, copied, manipulated and thus forged. In the case of paper certificates, efforts are made to prevent these possibilities, e.g. by using special types of paper, embossing, stamps, seals or signatures of authorized persons. In the case of digital documents, cryptographic techniques can also be used to significantly reduce the possibility of alteration. The DigiCerts, of which our institute is a member, has developed a solution based on a consortial blockchain (see https://www.digicerts.de/). This means that the hashes of the issued certificates are written to the blockchain and can also be subsequently verified via the blockchain. If the document has been manipulated, the hash will no longer be valid. As part of the DigiCerts consortium, we have already developed a Moodle plug-in that can be used to issue digital certificates. The blockchain technology approach is currently being debated [8, 7], particularly in favor of using less complex cryptographic techniques, e.g. public key infrastructure (PKI). However, the specific technical implementation of the verification features is not relevant for this article.

3. However, the benefits of digital certificates will only be realized if they are made available to as many stakeholders as possible. The PIM project (Platform for International Student Mobility, https://pim-plattform.de/en/), in which our institute is involved, aims to facilitate the mutual recognition of academic achievements through the use of a database. Time-consuming case-by-case checks will no longer be necessary and will be replaced by an **automated matching process**. This could significantly reduce the resources required by higher education institutions to carry out the checks, thus overcoming a major barrier to students requesting such checks at all. As a result, more competences acquired outside higher education could possibly be recognized. Digital certificates with a stan-

dardized description of the academic achievement provide the basis for this recognition.

In the future, digital certificates should enable further services, e.g. to improve the search for interesting job offers or to make suggestions for useful further qualifications [3].

3 Identification of Challenges beyond technology and further workshop results

Once the technical progress was mature, digital certificates have been tested in the first online courses. Both MOOCs on the FutureLearnLab platform (https://futurelearnlab.de/hub/) and online courses available only to students from the federal state of Schleswig-Holstein via the FutureSkills platform (https://futureskills-sh.de/) were selected. As the first trials raised a number of issues that could not be resolved at a technical level, a series of workshops were organized to address the main requirements for the implementation of digital certificates.

For the workshops, an open invitation was sent to three departments of TH Lübeck: Institute for Interactive Systems (ISy) is a research institute and competence center in the field of digital learning solutions and interactive systems. The Centre for Digital Teaching is a service unit of the university that supports educators on issues related to digital teaching and learning. The oncampus GmbH is a company and a wholly-owned subsidiary of the TH Lübeck, providing academic professional development programs and infrastructure services for university networks and schools.

The resulting team for the workshops was interdisciplinary: In addition to Moodle developers, blockchain, media and UX experts, the instructional designers provide the link to professional authors. Program managers and project developers have many years of experience with the structures and processes of universities as well as the policy objectives of the federal and state governments.

As a first step, issues related to the handling of digital certificates were collected, clustered and divided into topics for a series of workshops. The challenges identified can be divided into three main groups (with examples of questions):

1. Questions about instructional design: At what point in the course or platform will it be useful to issue digital certificates? What explanatory text is needed? What design elements should or can be used for better recognition?

2. Questions about the current level of competence and required competence development of all participants: What is the difference between digital certificates

and previous electronic documents (usually PDFs as well)? How can educators issue and sign digital certificates? How can learners archive their certificates? How can examination offices and boards verify digital certificates? What other stakeholders can use digital certificates and how? What do platform providers need to consider when implementing digital certificates?

3. Questions about institutionalization in universities and other (educational) institutions: Who is authorized to issue certificates? Who decides if they are valid? What are possible frauds and how can they be prevented or contained? What preparations need to be made for a sustainable infrastructure?

The complexity of these questions increases in this list: questions about the design of teaching are rather easy to answer and only help to reduce the workload by providing standardized guidelines and templates. Questions about institutionalization in universities sometimes require the extension or redesign of existing structures. For example, the DigiCerts concept recognizes certifying authorities (e.g. a university) and certifying persons (e.g. a staff member in the examination office or individual lecturers). How and by whom these roles can be assigned is a matter for the individual higher education institution, which needs to understand this concept. It is also necessary to consider whether the legal framework of the higher education institutions is sufficient or whether extensive change processes need to be initiated here as well.

A first key outcome was a **sharpened understanding and scope of different types of credentials**. In general, digital credentials can

- document learning achievements (portfolio function),
- serve as record for third parties (access function), and
- support gamification (motivational function).

Basic Moodle certificates are only used for platform-internal documentation and processing, or outside the certificate consortium. Digital certificates, on the other hand, are machine readable and verifiable, which makes them important as proof for third parties. Digital badges, in turn, are mainly used to increase motivation (gamification), also because their acceptance beyond particular platforms is rather low.

When introducing digital certificates, it is important to **support recognized standards** such as ESCO from the European Union's Europass framework [1]. Otherwise, the value of the certificates is unclear. Although these standards are seldom supported for paper certificates, the resulting added value only comes into play with digital certificates because they are processed afterwards. Conversely, without the support of standards, digital certificates add complexity and extra effort to the development of services based on them. However, with this conclusion comes the awareness that the visual representation of certificates is likely to contain only a subset of the machine-readable data. For example, a full representation of the ESCO competences on which Europass is based would require several pages of text for even the simplest certificates of participation.

Verification of authenticity also remains a key function of digital certificates. This poses a particular challenge when it comes to organizational and institutional processes: On the one hand, it should be possible to correct typing errors or altered data, e.g. vital records, but on the other hand, it should not be possible to manipulate data without authorization. The cryptographic method must be suitable for this, but it should also be possible to prevent as many variants of social hacking as possible. Again, paper certificates are far from secure against tampering, but digital certificates can provide additional protection through authorization mechanisms, rights and roles.

A major challenge in implementing digital certificates in everyday university life is the **sustainability** of the implemented solutions. Paper certificates can be read for decades, if not centuries. In contrast, it is already being discussed whether the implemented technical solution based on a consortial blockchain is too complex and could be achieved with less complex approaches like PKI. Future development is therefore open to a variety of alternative technologies.

Last but not least, the **development of skills** in handling digital certificates is considered to be of great importance for the success of digital certificates for all stakeholders. In contrast to simple electronic documents, digital certificates are not simply a one-to-one reproduction of the paper version; they bring new possibilities, but also new requirements. The use of digital certificates in universities is not yet well established and needs to be understood by all parties involved.

- Learners need to understand, for example, that although the digital certificate (in our implementation) is a PDF, the essential content is in the embedded metadata (in our implementation as JSON).
- Educators need to understand how digital certificates are signed and the importance of careful handling of the required private key.
- Examination authorities and other recipients of the certificates need to understand how to validate them and that it is not enough to look at the visually presented information on the PDF page.

Each educational institution will need different sets of information materials, which strongly encourages the publication of such materials as Open Educational Resources (OER).

4 Conclusion and outlook

Digital certificates have the potential to finally fulfill one of the first hopes of MOOCs: the transversal recognition of learning outcomes and thus improved educational and labor mobility. Although based on paper documents and (often one-page) PDF files, they cover much more by providing machine-readable and standardized components for describing competences. Their key advantage is that they can be issued, verified and further processed automatically. Services based on them, such as recognition databases, are envisaged by both the public and private sectors and are already under development.

The current implementation of DigiCerts provides a PDF file with integrated metadata in JSON format to support both machine and human readability. However, visualization in particular needs to be made much simpler if standards such as ESCO are to be supported and a compact, human-readable presentation is to be ensured. We anticipate that higher education institutions will need a high level of support in making the transition and, in particular, in understanding the benefits of digital certificates.

It remains to be seen whether the DigiCerts' technical solution, based on a consortial blockchain, will take hold. Other verification options like PKI may also emerge in the future. Another question that remains to be answered is whether the new roles required to issue digital certificates (e.g. certification authorities) can be filled by existing people (e.g. lecturers or examination office staff) or whether entirely new positions will have to be created.

Finally, digital certificates cannot overcome the limitations of credentials in general. These include, for example, the need to verify the identity of the learner and, where applicable, of the person issuing the certificate, so that ghost writing or other models of fraud cannot be applied. Similarly, digital certificates cannot tell us whether the constructive alignment was appropriate, nor the extent to which competences can be maintained over time without further practice. Finally, it is difficult to consider competences that were primarily developed in informal contexts. These include, for example, the 4C competences (communication, collaboration, creativity and critical thinking, [10]. In these cases, alternative approaches like placement tests remain useful.

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How to Reuse Inclusive Stem Moocs in Blended Settings to Engage Young Girls to Scientific Careers

Ana Moura Santos[1], Paola Corti[2], and Luis Felipe Coimbra Costa[3]

[1] Instituto Superior Técnico, University of Lisbon
Av. Rovisco Pais 1049-001 Lisboa, Portugal
[2] METID, Politecnico di Milano
Piazza Leonardo da Vinci, 32 20133 Milan, Italy
[3] Instituto Superior Técnico, University of Lisbon
Federal University of Rio de Janeiro

The FOSTWOM project (2019–2022), an ERASMUS+ funding, gave METID (Politecnico di Milano) and the MOOC Técnico (Instituto Superior Técnico, University of Lisbon), together with other partners, the opportunity to support the design and creation of gender-inclusive MOOCs. Among other project outputs, we designed a toolkit and a framework that enabled the production of two MOOCs for undergraduate and graduate students in Science, Technology, Engineering and Maths (STEM) and used them as academic content free of gender stereotypes about intellectual ability. In this short paper, the authors aim to 1) briefly share the main outputs of the project; 2) tell the story of how the FOSTWOM approach together with 3) a motivational strategy, the Heroine's Learning Journey, proved to be effective in the context of rural and marginal areas in Brazil, with young girls as a specific target audience.

1 Introduction

METID, the learning innovation Unit of Politecnico di Milano, and MOOC Técnico from Instituto Superior Técnico of the University of Lisbon, together with other partners, had the opportunity to develop a toolkit and a framework to support the creation of gender-inclusive STEM (Science, Technology, Engineering and Maths) MOOCs. As a result of an ERASMUS+ funding opportunity, the FOSTWOM project[4] produced firstly the toolkit and a MOOC for educators that explained this framework, and then two MOOCs free of gender stereotypes about intellectual ability aimed to undergraduate and graduate students in STEM. The inclusive

[4] https://fostwom.eu/

potential of MOOCs has proved to be effective in more than one context so far and our experiment re-enforces that fact.

The FOSTWOM project's team developed a toolkit[5] open to MOOCs stakeholders, content experts, instructional and graphic designers, that can guide them to create more inclusive STEM MOOCs. Then, based on the toolkit guidelines, the "Machine Learning, Maths & Ethics: Hands-on" online course was developed, using gender-conscious perspective in narratives, in the video and text language, in the use of images, and in the interviews. Parallel to this, two of the authors developed a motivational strategy for following STEM MOOCs, the Heroine's Learning Journey (HLJ)[6]. Acting as a path to follow the MOOC, the HLJ functioned as a motivational narrative metaphor for the internal challenges of (female) STEM students, trying to overcome their own fears and challenges in the STEM field. Thus, after translating all content into Portuguese, a second edition of the MOOC "Machine Learning, Maths & Ethics: Hands-on" with the HLJ embedded was put in place. This edition of the STEM MOOC proved to be effective, particularly, in the context of rural and marginal areas in Brazil, with young girls as a specific target audience.

A high-school teacher from the city of Recreio-Minas Gerais, Brazil, supported the FOSTWOM MOOCs initiative and facilitated the use of the school computer lab so that students could take the online course using the lab computers. In addition, to help overcome the technical difficulties posed by the subject of the MOOC itself, namely, machine learning algorithms and maths, a young researcher from the Federal University of Rio de Janeiro, Brazil, provided online individualised support to the participants from Recreio.

In section 2 of this short paper, the authors aim to briefly share the main outputs of the project itself and in section 3, to report the experiment of how the FOSTWOM approach together with the motivational strategy of the HLJ proved to be effective for young girls from rural and marginal areas in Brazil. By efficient we mean that from the group of the 14 young girls who had the opportunity to count on the special support of the school and the tutor, 11 received the honour certificate of completion of the MOOC and gave very positive feedback on their willingness to pursue STEM studies. Finally, in the last section, we try to draw some conclusions and leave some comments that we find relevant.

[5]See in https://fostwom.eu/

[6]https://heroicjourneys.life/journey-heroine

2 FOSTWOM project (2019–2022)

MOOCs are a vivid and innovative field of experimentation. The COVID-19 pandemic helped quicken some development areas because of the high demand for online content. Then after the pandemic emergency, the "new normal" became a hybrid approach to learning experiences. This means MOOCs continue to occupy a relevant position worldwide and offer many learning opportunities. These opportunities, however, come with their own limits and are often still keen to divide learning opportunities into silos: scientific content on one side is targeted for STEM male students, and arts and humanities content is aimed at a female public with social and cultural concerns [3]. MOOCs' gender stereotypes and under-representation of women in STEM affect the way girls and young women perceive themselves and their intellectual skills, and it is one of the reasons for their limited presence in the STEM field [1]. Believing that MOOC and gender-balanced educational content in general can be part of the solution, the FOSTWOM Project (2019–2022) developed a toolkit open to MOOCs stakeholders, content experts, instructional and graphic designers, that could guide them to create more inclusive STEM MOOCs. The result ended up being an offer of a practical tool to all people willing to create educational content from a gender-conscious perspective. METID team, in collaboration with other FOSTWOM partners, then designed and produced a MOOC for educators presenting the toolkit. In the MOOC "Fostering Women's Participation to STEM through MOOCs"[7], aside from a general reflection on educational content based on the toolkit and with a particular focus on content choices and storytelling to be used, gender-aware language, gender-aware use of images and visual materials; participants can also listen to the voices of people who work for a more inclusive environment in the STEM field. This MOOC was launched in 2021 for the first time on POK (Politecnico di Milano), and since then, already ran several times there, and once on MOOC Técnico (Instituto Superior Técnico of University of Lisbon), UPVx (Universitat Politècnica de València) and edX.

Then, a second MOOC was designed and produced within the FOSTWOM Project, the "Machine Learning, Maths & Ethics: Hands-on", with its first edition (2021) launched on the MOOC Técnico platform[8]. As the MOOC's teaser reads: "The course allows you to develop practical skills to build algorithms and stimulate critical thinking on the ethics of machine learning models. Did you know that nowadays girls and women are still under-represented in the fields of computer science, artificial intelligence and machine learning? We expect this MOOC to be

[7] https://www.pok.polimi.it/courses/course-v1:Polimi+FWM101+2022_M7/about

[8] https://courses.elearning.tecnico.ulisboa.pt/courses/course-v1:MOOCs+lematecX+2021/about

a meaningful learning opportunity to empower young people, especially young women to follow these areas of expertise." In creating this FOSTWOM online course, the MOOC Técnico team followed the guidelines of the toolkit and the previous experience of the partnership in order to introduce a gender-conscious perspective in narratives, language, and in the use of images. This MOOC was subsequently launched on the platforms POK and UPVx in 2022.

3 The Machine Learning, maths & ethics MOOC in Recreio (brazil)

In the second edition (April 2022) of the course "Machine Learning, Maths & Ethics: Hands-on" on MOOC Técnico[9], an effort has been made to translate every text, video transcript and assessment activities into Portuguese. Moreover, a software embedded in the MOOC allowed any person enrolled in the course to follow the path of a Heroine's Learning Journey (HLJ) which functions as a motivational narrative metaphor for the internal challenges of (female) STEM students, trying to overcome their own fears and challenges in a STEM educational environment and become better learners. During this second edition of the MOOC, with 366 participants enrolled in total, additional resources for the day were provided, such as a Discord group for discussion, a YouTube channel for additional and optional lessons, extra support by two tutors dedicated to the course discussion forum, and for conducting optional assessment activities.

By the time the course was being advertised online in Portugal and Brazil, a high-school teacher from the city of Recreio-MG, Brazil, became interested in bringing the initiative to his city from a region in the interior of Minas Gerais. In order for some young female students to participate in the course, it was necessary to partner with the Olavo Bilac State School. The school provided the computer lab so that students could participate in the course, since a large part of the girls did not have devices and internet access at home. Additionally, for this special context, an online course tutor, a teacher assistant from the Federal University of Rio de Janeiro (Brazil), was made available, who set aside one day a week to provide synchronous sessions to the Recreio participants and created a WhatsApp group for facilitating communication.

In total, 30 young high school girls applied for participating in the experiment, filling in the initial form for attending the MOOC plus the lab training, made available by the schoolteacher, two months before the course started. After a previous

[9] https://courses.elearning.tecnico.ulisboa.pt/courses/course-v1:MOOCs+lematecX+2022/about

selection based on profile and self-motivation, 14 young women[10], aged between 15 and 21 years old, were selected for having the opportunity of the three-month training with the MOOC "Machine Learning, Maths & Ethics", and from them 11 girls completed the course receiving the honour certificate from Instituto Superior Técnico of the University of Lisbon. Notice that from the total number of 366 enrolees in the second edition (April 2022) of the MOOC, 67 certificates were issued at the end, which makes the rate of 11 out of 14 young women obtaining the honor certificate of the MOOC even more impressive.

In June 2022, a survey was conducted in Olavo Bilac State School. Several young girls, who participated in the training, voluntarily submitted their answers to the survey. The average age of these young women was 16.5 years old. The survey questions were as follows: socio-demographic questions (3), degree of satisfaction with the training and the corresponding supports (3), perceived relevance of the training (1), difficulties experienced during the training (1), and future expectations (2).

In this participatory experiment with Brazilian girls, we can clearly identify two important strategies that act as strong motivators to increase the number of women in the STEM area. These motivators, that is, indicators of a positive influence on gender balance in STEM, corroborate what is written in the scientific literature. The first indicator is the support of the school, teachers, and family. In the blended training carried out in the Recreio school, we consider that the possibility of using the lab computers was fundamental. According to [2], school support was reported as a determining factor for girls to choose to major in engineering. The school environment favours the empowerment of girls by increasing self-confidence about their abilities to work in STEM topics. Such exposure also helps to overcome the fear of disciplines that, due to gender stereotypes, are considered (more) suitable for men, such as maths.

In fact, one of the biggest learning difficulties reported by the young women, when they started training, was mathematics. Several times during the training, the tutor helped the girls overcome computational and programming difficulties and actually had a positive impact giving the girls courage to surmount the initial difficulties. As a result, on the mid-training survey, 62 % of the young women stated that they were considering working in the technology field and 75 % considered continuing to improve their knowledge in STEM in the near future. We can identify in this experiment the other strong motivator for bringing gender balance to STEM, which is the existence of role models [5, 4]. We can see in the presence and performance of the tutor, a young researcher from the University of Rio de Janeiro, a strong impact of a role model, providing the young women assistance and giving them the self-confidence that they so desperately needed.

[10] This was the actual computer lab capacity.

Figure 1: Young women participants with school A teachers from Recreio-MG/ Brazil

In general, strategies on role models occur when girls have direct or indirect contact with women working in STEM, through lectures and discussions in which these women's careers and challenges are discussed [5, 4]. It was already observed that the presence of actual women in STEM stimulates girls to participate in programming workshops [5]. Even more, having female scientists sharing their experiences and challenges with high school girls and undergraduate students has a positive effect on their feeling of belonging in STEM and encourages them to pursue their studies and careers [6].

4 Conclusion

With this unique experiment, although limited in number, with high school girls from the city of Recreio-MG in Brazil, we could clearly identify at least two important strategies that can play the role of strong motivators to increase the number of women in STEM careers: School support and contact with role models in STEM

Figure 2: Young women receiving MOOC support in Recreio-MG/Brazil

careers. These are positive factors that can inspire young girls to feel that they belong in STEM and give them the self-confidence to pursue their studies in the field. We want to emphasize that this experiment was made possible by the (re)use of a MOOC designed to be inclusive, avoiding the standard stereotypes on gender skills, and of a HLJ motivational narrative created to help overcome the internal challenges of (female) STEM students.

The authors of this short paper as co-creators and instructional designers of MOOC content, as active partners in the FOSTWOM project and as co-creators of the Heroine's Learning Journey, feel very grateful for the opportunity of seeing their efforts translated into real changes in the lives of the Brazilian girls. Despite the fact that it is not always easy to have the human resources and the institutional support to do that, we will do our best to take this experiment to more students and schools.

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xMOOCs

A Modality for Mass Reach During the Pandemic for the World Health Organization

Heini Utunen, Melissa Attias, and Anna Tokar

World Health Organization
Avenue Appia 20, 1211 Geneva, Switzerland

The World Health Organization designed OpenWHO.org to provide an inclusive and accessible online environment to equip learners across the globe with critical up-to-date information and to be able to effectively protect themselves in health emergencies. The platform thus focuses on the eXtended Massive Open Online Course (xMOOC) modality – content-focused and expert-driven, one-to-many modelled, and self-paced for scalable learning. In this paper, we describe how OpenWHO utilized xMOOCs to reach mass audiences during the COVID-19 pandemic; the paper specifically examines the accessibility, language inclusivity and adaptability of hosted xMOOCs. As of February 2023, OpenWHO had 7.5 million enrolments across 200 xMOOCs on health emergency, epidemic, pandemic and other public health topics available across 65 languages, including 46 courses targeted for the COVID-19 pandemic. Our results suggest that the xMOOC modality allowed OpenWHO to expand learning during the pandemic to previously underrepresented groups, including women, participants ages 70 and older, and learners younger than age 20. The OpenWHO use case shows that xMOOCs should be considered when there is a need for massive knowledge transfer in health emergency situations, yet the approach should be context-specific according to the type of health emergency, targeted population and region. Our evidence also supports previous calls to put intervention elements that contribute to removing barriers to access at the core of learning and health information dissemination. Equity must be the fundamental principle and organizing criteria for public health work.

1 Introduction

The World Health Organization (WHO) launched its `OpenWHO.org` learning platform in June 2017 in anticipation of the massive knowledge transfer needs of the next pandemic. The platform was designed to reach learners across the globe with critical learning to protect themselves and their communities using a variety of features to maximize access. Courses are self-paced and provided free of charge, with options for low-bandwidth and offline access through a mobile application, and available in multiple formats and languages to connect with as many learners as possible.

OpenWHO has made effective use of its self-paced learning platform and successfully adapted materials for offline capacity-building activities, often in remote areas where connectivity may be problematic or unavailable. This has required harnessing new technology, and scaling up course production, formats, dissemination channels and languages. It has also required improving the user experience and usability of the materials on the learning platform while maintaining access for both those who do not have sufficient connectivity to high-bandwidth internet along with those who can easily join.

Massive Open Online Courses (MOOCs) have existed for more than a decade and have provided completely new ways of learning. While online learning does not necessarily need to take place at a distance, in this context it will refer to distance, non-personalized, dispersed online learning.

The benefits of online learning, particularly during a pandemic when all other opportunities are limited, are indisputable [14]. However, in some contexts online-learning approaches may be not feasible or may have limited reach due to barriers such as a low level of digital literacy and technical capacity, poor or no internet access, and other similar obstacles that could be related to digital devices. In some contexts, there is a preference to learn in a group setting or use materials independently outside the platform premise. In these situations, it is key to have alternative means of digitalized materials for information dissemination that are shared through learning organizers, individuals or organizations. There is a need to transform digitalized learning materials into offline or alternative versions accessible to audiences who need them in a particular format.

The constant change related to health information and advice is a driver for audiences to join and re-join learning to refresh their knowledge, especially in the case of novel infectious diseases. The pandemic response required millions of people, especially frontline responders, to access lifesaving information to protect themselves and help others. Fast-tracking the development and delivery of learning and information dissemination materials during an emergency is necessary and issues of access are to be highlighted.

Finset et al. [4] summarized that a global pandemic situation requires a broad, interdisciplinary response in which "professionals in the fields of communication, education, and health behavior change need to take responsibility for carefully evaluating what is known and insights currently emerging". Open media and materials of the internet have the power to enable wide dissemination, but also pose risks such as misinformation. Recent research has highlighted the need to leverage health communication to help fight the COVID-19 infodemic [8, 12] in which the role of the authorities is to lead in conceptualizing and contextualizing the health information. According to Paakkari et al. [11], COVID-19 has shown that health literacy could help people to understand science and make related choices and decisions.

The approach of OpenWHO is that of asynchronous information and learning dissemination in which learning occurs in online educational environments without teacher and student interaction and only in self-paced formats without learners interacting at the same time [15, 2]. While the studies and literature often refer to degree-building MOOCs, xMOOCs (eXtended MOOCs) are freely accessible without cost and disseminated openly, not as part of a degree program or graded learning program; in the case of OpenWHO, the courses are aimed at continuous education for those who are already professionals, or anyone interested in the public health information provided.

OpenWHO focuses on xMOOCs that are content-focused and expert-driven, from one-to-many models, for scalable learning [1]. xMOOCs have a strong focus on the content transmission and acquisition features. They utilize the instructivist approach where expert instruction plays a major role and courses have automated assessment. In xMOOCs, learners can take and complete the courses without any participatory elements. The xMOOC format is not limited, however, and could include opportunities for networking, such as discussion forums and joint task completion. Mazoue et al. [7] suggested that the xMOOCs can optimize learning through highly defined and composed online content materials that are accompanied by assessments.

Impact and learning outcomes of asynchronous learning are not largely weighed in current xMOOC research. Most research into online education is related to topics, content resources, inputs and student views. Attention is mostly put on designer, employer and client and their views [6, 3].

The COVID-19 pandemic hit at a time when internet penetration and use of internet-based solutions via various gadgets was higher than ever before. Evidence deriving from the Organization for Economic Co-operation and Development (OECD) [10] states that web searches on training online were four times higher in March-April 2020. The number of enrollments in online courses on degree-producing platforms such as Coursera, edX and FutureLearn reached 180 million by 2020, with one third of all learners who ever joined a MOOC platform doing so in 2020. Learning and education were among the principally disrupted sectors during the COVID-19 pandemic, but at the same time, the online means provided a continued manner of staying active and learning for those who had connectivity and means to connect [16].

This paper reports on OpenWHO's experience of utilizing the xMOOC modality to reach mass audiences during the COVID-19 pandemic.

2 Self-Paced Learning for the Pandemic

2.1 Key OpenWHO milestones

OpenWHO, launched in June 2017, initially hosed courses and materials supporting preparedness and response interventions for disease outbreaks occurring at that time: Ebola (in the Democratic Republic of the Congo), Pneumonic plague (in Madagascar) and Diphtheria (in Cox Bazar, Bangladesh). During the first year, there were 49,000 enrolments.

After the "Introduction to COVID-19" course became available on the platform in January 2020, the enrollment rate started to increase drastically, with the course reaching 232,890 enrolments in the first three months [21]. The course was translated in 13 languages, allowing participants to access learning materials in their native languages in a timely manner. All in all, about a half of learners (53 %) enrolled in the "Introduction to COVID-19" course were new learners to the OpenWHO platform and in the first ten weeks following the pandemic declaration, learners used the learning platform most in countries with the highest COVID-19 cases [20]. The introductory COVID-19 course has continued to be the most popular course on the platform, growing to more than 1 million enrolments across 45 languages. In total, OpenWHO hosted 7.5 million enrollments in 200 xMOOCs on public health topics across 65 languages as of February 2023, including 46 courses targeted to the COVID-19 pandemic (Figure 1).

2.2 OpenWHO xMOOCs: accessibility, language inclusivity and adaptability

The OpenWHO learning platform reaches a diverse global audience: Learners hail from all countries of the world and every age group, with nearly $\frac{2}{3}$ of learners between the ages of 20 and 39 (65.2 %). The platform serves slightly more women (51.7 %) than men (48.2 %), and is most used by learners who identify as students (38.7 %) and health care professionals (24.7 %). On average, OpenWHO learners participate in two courses each, with a course completion rate of 53.9 %. In total, more than 4 million course certificates have been awarded to OpenWHO learners.

It is crucial for the OpenWHO platform as a health emergency learning solution to address persistent knowledge needs and gaps, as well as reach underserved

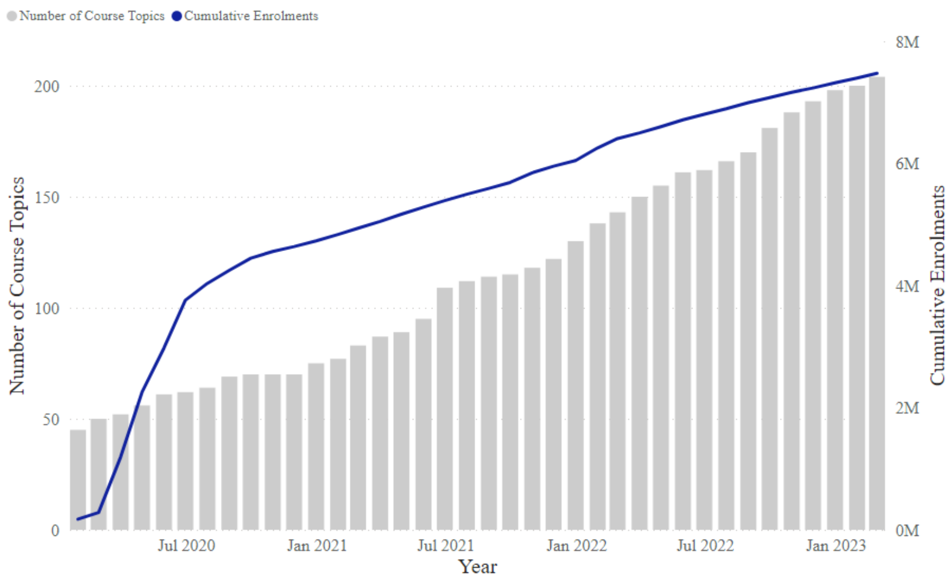

Figure 1: Growth in courses and enrolments on the OpenWHO platform during the COVID-19 pandemic

groups and contexts. To do so, OpenWHO prioritized the accessibility, language inclusivity and adaptability of hosted xMOOCs.

All course materials are available for participants 24/7 in different formats (e.g. videos, downloadable documents, slides, quizzes and learning exercises). According to survey results, learners found the self-paced and flexible nature of the courses to be useful [5]. OpenWHO also prioritizes free multi-use formats so materials can be adapted to local and offline contexts, creating a multiplier effect. Countries worldwide have described using these materials for training fieldworkers, local dissemination, use in social networks, microlearning, adaptation to university courses, precision group targeting and hybrid models [19]. As a result, the knowledge disseminated via local networks could have profound reach, leading to even higher overall knowledge coverage.

Moreover, OpenWHO aims to provide language inclusivity by facilitating timely access to life-saving knowledge for participants in their native languages. Currently, courses are available in 65 languages to enhance learning uptake and retention, including the official languages of every WHO region, 19 of the 20 most-spoken languages worldwide and the official languages of 44 out of 46 of the least-developed countries. OpenWHO continues to invest in language inclusivity, translating courses into as many languages as feasible. A total of 15.7 million words have been translated to strengthen equitable access to public health knowledge, with a focus on languages spoken by vulnerable or underserved populations in low- and middle-income countries.

To support learning tailored to country contexts, OpenWHO initiated a feature during the COVID-19 pandemic that enables WHO Country Offices to collaborate with the global platform to launch country-specific learning channels. The channels provide learners with access to OpenWHO courses in their country's national languages or for their unique context through a single link, centralizing relevant country resources under one hub. Known as the Serving Countries portal, this feature currently hosts 15 country-specific channels with courses that address various aspects of the COVID-19 pandemic as well as public health more broadly.

As a result of these efforts, the COVID-19 xMOOCs hosted by OpenWHO expanded learning to previously underrepresented groups, such as women, participants ages 70 and older, and learners younger than age 20. It was also observed that participation shifted toward low-and middle-income countries, which contribute nearly $\frac{2}{3}$ of learners compared to $\frac{1}{2}$ before the pandemic. When population is taken into consideration, small island states bring the highest proportion of learners, representing 16 out of the 20 top countries, territories and areas (Figure 2).

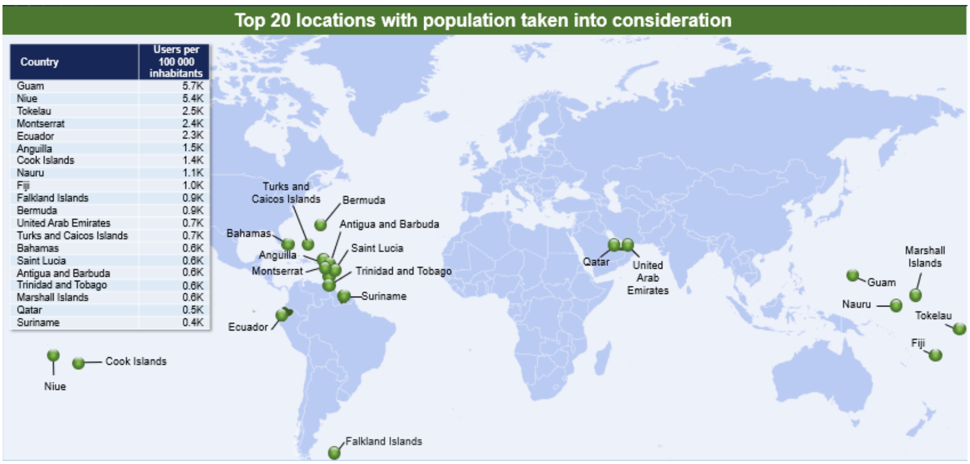

Figure 2: OpenWHO per capita enrolments

WHO plans to continue to utilize self-paced MOOCs beyond epidemic and pandemic contexts to support the learning response in fragile, conflict-affected and vulnerable settings, for which access is often particularly compromised or limited. Approximately 7 % of OpenWHO learners are currently from the 37 countries and territories on the World Bank's fiscal 2023 list of fragile and conflict-affected situations [17]. These learners are primarily from younger age groups, with 49 % aged 20–29 and 33 % aged 30–39 (Figure 3). 19 % of learners from fragile and conflict-affected countries are students, 14 % are healthcare professionals, 10 % are volunteers and 10 % are from health ministries. The most popular courses for fragile and conflict-affected contexts based on the number of enrollments are those targeted to the COVID-19 pandemic, followed by courses on cholera, WHO's Incident Management System for emergencies, antimicrobial stewardship, mpox and Ebola. OpenWHO also hosts a Ukraine-specific learning channel that offers 24 different courses in Ukrainian to help strengthen public health during the ongoing emergency, and has produced courses aimed at key humanitarian issues including food insecurity and water, sanitation and hygiene.

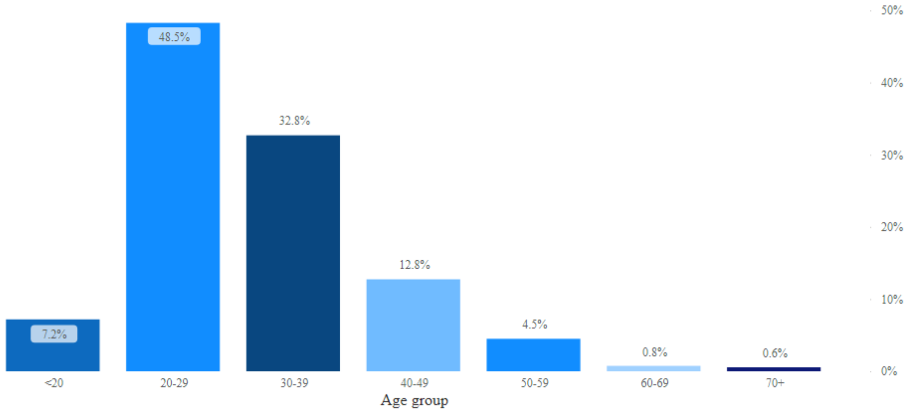

Figure 3: Age distribution of OpenWHO learners in fragile and conflict-affected countries

3 Conclusion

All in all, the COVID-19 pandemic has shown that learning to protect the health of oneself and others is important and required in emergencies. Access to up-to-date guidance can be facilitated through asynchronous learning delivery. Based on these findings, it can be seen that xMOOCs, with their one-directional and instructor-led approaches, can work for the purpose of mass dissemination as a critical first knowledge component.

Even though xMOOCs have been criticized as top-down and authoritarian, they may serve the purpose for instant, rapid, fast and frequent information dissemination [13]. It is recognized that more targeted, interactive learning programs with peer-learning and intense moderation work through cMOOCs. They are suited for audiences that demand small audience sizes that are manageable. xMOOCs are naturally considered for other types of learning outcomes where digitalized learning journeys need to be addressed for large audiences and immediate knowledge needs. While more personalized, skills-building and behavior-change learning is required through cMOOCs, and those moderated and interactive sessions and synchronous formats are needed, there is an equal need for the asynchronous, xMOOC modality. The massive scale learning response is well placed to begin with the self-paced asynchronous and instructivist delivery of health information as the science emerges and evolves.

The OpenWHO pandemic learning response can serve as an example of applying the xMOOC approach to inform the body of knowledge on how public health information dissemination in asynchronous online learning formats can best meet the requirements of populations in need of health information in a public health emergency. In addition to reaching underserved populations, the OpenWHO case notably suggests that xMOOCs can motivate learners in spite of their self-directed nature and produce high course completion rates. The findings support the position that asynchronous, one-directional information dissemination has a valid place in the online learning offering, especially in sudden-onset emergencies that touch the whole world, such as the COVID-19 pandemic.

As described by previous research, xMOOCs should be recognized as a suitable MOOC type to disseminate knowledge on a massive scale, such as in a public health emergency. The instructivist [1, 9] and prescriptive [22] learning methods that are expert-driven suit information dissemination for mass audiences in emergencies. Despite the critique on instructivist and prescriptive learning, they do fulfill a purpose when real-time emergency learning is required at scale, and do so better than other modalities. This controlled and structured content is key for sudden onset events, where reliable and expert-driven information needs to be widely disseminated, especially in the era of the infodemics. They may be particularly effective for multiplying the reach of critical knowledge in fragile and hard-to-reach settings, given the low-bandwidth and offline modalities available for this type of learning. Yet, further research should carefully address issues of effectiveness and efficiency of xMOOC utilization across different emergency contexts and populations.

Our work also adds to the empirical information available on xMOOC providers of self-paced, asynchronous learning, the scope to which this work is limited. It adds to the body of evidence for health information dissemination in emergency learning contexts. It also provides applicable and practical approaches to learning through online platforms in sudden-onset events, in which one-directional learning transfer ensures rigid and robust information flow from experts and authorities to the public and larger audiences.

Adjusting materials for health information dissemination supports ownership and allows validation of the dissemination to health professionals and communities, which in turn will minimize misinformation and lead to better learning outcomes. Organizations offering emergency-related or other health information dissemination through learning could use such approaches in designing and delivering learning conducive to multiplication. The providers of similar learning and health information dissemination can draw from these findings and key considerations to respond to rapidly changing information needs.

Finally, we argue that constant pursuit of equitable access to knowledge is required for policymakers, planners and organizations with public outreach functions. Scientifically based health information dissemination needs to be established by organizations mandated to respond to any public health threat in a fast and scalable way. Elements that contribute to removing barriers to access, including language, must be at the core of learning and health information dissemination intervention of this scale. Equity must be the underlying principle and organizing criteria for public health work. Without equity in access to sources of trusted information, there cannot be adequate access to health and better health outcomes, including in public health emergencies where there is a critical need to quickly protect individuals and populations.

Acknowledgment

The authors would like to express their gratitude to the entire OpenWHO team, from those who developed and launched the platform in 2017, to the expanded team who met the surge in demand for information during the COVID-19 pandemic. In particular, they would like to acknowledge Paula Christen and Ngouille Ndiaye for their support with data management and analysis. The article uses the findings of the PhD dissertation of lead author of the paper [18].

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The Comooc Model for Global Professional Collaboration on Sustainability

Eileen Kennedy[1], Diana Laurillard[1], and Samar Zeitoun[2]

[1] UCL
UCL Knowledge Lab, 23-29 Emerald St, London WC1N 3QS, UK
[2] Lebanese University
Tayouneh, Kalot building, Beirut, Lebanon

This paper presents a new design for MOOCs for professional development of skills needed to meet the UN Sustainable Development Goals – the CoMOOC or Co-designed Massive Open Online Collaboration. The CoMOOC model is based on co-design with multiple stakeholders including end-users within the professional communities the CoMOOC aims to reach. This paper shows how the CoMOOC model could help the tertiary sector deliver on the UN Sustainable Development Goals (UNSDGs) – including but not limited to SDG 4 Education – by providing a more effective vehicle for professional development at a scale that the UNSDGs require. Interviews with professionals using MOOCs, and design-based research with professionals have informed the development of the CoMOOC model. This research shows that open, online, collaborative learning experiences are highly effective for building professional community knowledge. Moreover, this research shows that the collaborative learning design at the heart of the CoMOOC model is feasible cross-platform. Research with teachers working in crisis contexts in Lebanon, many of whom were refugees, will be presented to show how this form of large scale, co-designed, online learning can support professionals, even in the most challenging contexts, such as mass displacement, where expertise is urgently required.

1 Introduction

This paper presents a new design for MOOCs for professional development of skills needed to meet the UN Sustainable Development Goals – the CoMOOC or Co-designed Massive Open Online Collaboration. UNSDG 4 challenges us to find ways to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. The CoMOOC model addresses SDG 4 by engaging professionals in many fields to share their own practical insights and build community knowledge of what works that is relevant to multiple SDGs. For example, teachers can share practice to provide quality education (SDG 4), engineers can share knowledge of clean water and sanitation (SDG 6) and affordable and clean energy (SDG 7) or health care workers can share practice related to good health and wellbeing (SDG 3).

Since 2017 researchers at the RELIEF Centre have been collaborating with education stakeholders (including universities and (I)NGOs) in Lebanon on a "Future Education" project designed to offer large-scale online support to teachers who were working in highly challenging circumstances to bring good quality teaching to students in the refugee camps and settlements. Based on an analysis of previous educational interventions of this kind [7] a co-design Theory of Change (ToC) for this type of intervention was developed. The five stages of the ToC (Engage, Develop, Extend, Embed, Sustain) and data is collected to evidence the progress of each stage thereafter. Guided by the ToC, the RELIEF Centre has developed teacher professional development (TPD) CoMOOCs in a way that embeds this new form of TPD into the universities' and NGOs' methods of teacher training, and enables these organizations to take over and sustain the approach in the longer term.

This research has demonstrated that the CoMOOC model is effective to provide the kind of peer learning, support and community knowledge building that is necessary for professionals in all fields in the context of increasing global challenges. To build this case, we present evidence from during the pandemic that the CoMOOC model was effective in supporting educators to move their teaching online and transform their approach to education.

2 The research context

The research reported here comes from a long-term funded project to find digital methods to support educators in Lebanon working in the challenging context of mass displacement. Lebanon, a country with the highest per capita number of refugees in the world, has experienced multiple, complex crises in recent years. While there have been many proposals to use digital technologies to support learners in this context, even those practices considered most promising focus on content delivery directly to the child while bypassing the teacher [10]. Yet, to provide environments that enable children to learn effectively with technology, a teacher is necessary. Delivering content alone is insufficient for learning and the best use of technology is to support cycles of communication between the child and the teacher that foster engagement [6]. Refugee children are particularly vulnerable learners, often suffering from trauma and having missed years of school [9]. These learners need teachers to mediate technology use more than ever.

Digital technologies are usually only understood as having value to students, but digital methods can be of value to teachers' learning too. [8] suggested that MOOCs were well suited to professionals wishing to update their skills and could enable TPD interventions to run at scale. By using digital methods to engage teachers to develop their own digital teaching competencies, digital approaches can complement teachers rather than circumvent them. Conceived in this way, [2] pointed out that digital methods have potential for TPD, within a broader framework of good practice, recognizing that:

> ICT has the potential to genuinely support teacher professional learning because it can bring models of good practice, provide quality resources and encourage dialogue between knowledgeable peers. It can be an impetus or catalyst to re-assess current or heavily embedded practice in teacher development, as it can create energy to review previously held assumptions by offering an alternative approach. ICT can help access difficult to reach locations . . . in remote areas. [2]

While concern is often expressed that digital infrastructure is not sufficiently developed to support online learning in many low-income and remote areas where it is most needed, the experience of this project is that it is now possible to reach most teachers and community leaders, if not students, via online methods. At the beginning of the project, we conducted workshops with stakeholders from universities and education-related NGOs in Lebanon. These workshops revealed a strong interest (and experience) in online learning in Lebanon from both NGOs and universities, who were enthusiastic about engaging in the co-design process. The workshops indicated that we would need to create the CoMOOCs in both Arabic and English – English because our university partners taught in English, and Arabic because NGOs working with Syrian refugees requested this to enable their teachers to engage. As a result, we have been working with two platform partners: FutureLearn for courses in English, and Edraak for courses in Arabic. Our ambition has been to create the same high quality, social learning experience across both platforms. In order to achieve this, we worked with Edraak to shift their instruction-focused learning design approach towards social learning and collaboration [4].

The pandemic further exacerbated the need for digital methods training for teachers. Even those teachers who had been sceptical or resistant to teaching online, now needed to look for ways that they could maintain continuity of teaching for their students who could not attend school in person. Since the RELIEF Centre CoMOOCs had already laid the groundwork for responding to this need, we were able to build on it in 3 ways:

- we rapidly co-designed a CoMOOC "*Teaching Online: Be Ready Now!*" in Arabic on the Edraak platform (47,000 enrolments from 2020)

- we re-ran our existing CoMOOC "Transforming Education in Challenging Environments" in English on FutureLearn and in Arabic on the Edraak platfrom (25,000 enrolments from 2019)
- we co-designed a CoMOOC "*Blended and Online Learning Design*" in English on FutureLearn (12,000 enrolments from 2021)

Since then, we have re-designed "Teaching Online" for post-pandemic contexts as "The New Era of Teaching and Learning" which has recently launched on Edraak. The aim of these courses was not only to introduce teachers to digital methods, but importantly to enable them to share with each other the practical knowledge they were rapidly acquiring during the pandemic. The speed at which teachers were adapting their practice meant that a traditional dissemination model from academic institution down to professionals was inappropriate, as teachers were finding out for themselves the best way to move around obstacles, such as poor internet, and home working environments. They needed to learn from each other and collaboratively build teaching knowledge together. This was the aim of the CoMOOCs we created.

3 The Co-Design approach as a Theory of Change

Our research in Lebanon has aimed to establish a generalizable approach to scaling up teacher professional development (TPD) using co-design to engage professionals such as teachers in developing new knowledge about online methods at a local and global level.

At the commencement of our research in Lebanon, therefore, we created an original ToC to plan implement and evaluate the steps the project undertakes to achieve this, and build up a portfolio of data to evidence the progress of each stage. There are five stages to the ToC illustrated in Figure 1: engage; develop; extend; embed; sustain. The aim is to guide the research and development of the intervention.

Stage 1 (engage): engaging the knowledge and support of local stakeholders to establish a shared vision of what is needed and what is to be planned. This can require a shift in perspective from conceiving of online learning in terms of the provision of digitalized resources, to one that prioritizes social and collaborative learning.

Stage 2 (develop): this process includes negotiating the curriculum and learning design for the CoMOOC, identifying what and whom to video among the partners, editing videos, and developing written text, discussion prompts and interactive

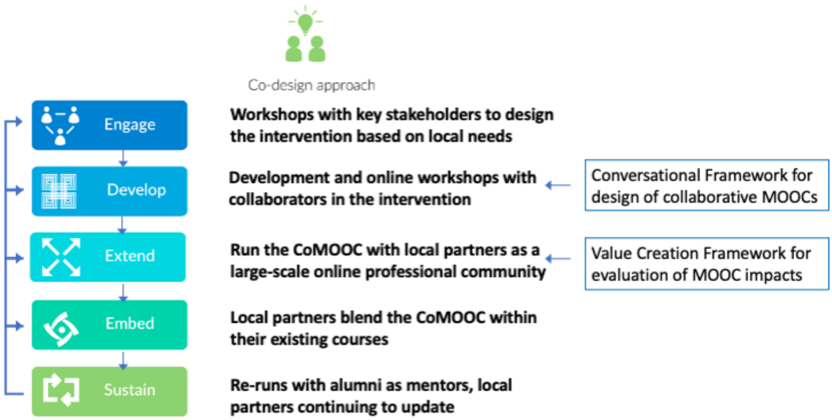

Figure 1: The Co-Design approach for the Theory of Change for educational interventions, in five iterative stages with nested frameworks for design and evaluation

and collaborative online exercises. The Conversational Framework informed this stage, as the basis for social and collaborative learning design of the CoMOOC.

Stage 3 (extend): running the CoMOOC multiple times to extend the professional development activities that had previously been run for small groups of teachers to many others in need of them through large scale online learning. Here co-design includes stakeholders moderating the discussion on the CoMOOCs and analyzing digital data. The Value Creation Framework provided the methodology for evaluation of the CoMOOC.

Stage 4 (embed): embedding the CoMOOCs in existing local provision of courses for teachers, by supporting co-design partners to blend them into professional development courses or workshops they are running.

Stage 5 (sustain): ensuring that partners are invested in the continued running of the courses to achieve their own outcomes, by updating them as needed, and taking the role of mentor to assist the educators (for example, in *Blended and Online Learning Design*, we have 42 alumni contributing high quality discussions and support).

4 Evaluation Methodology

To judge the nature of the impact of the CoMOOCs we needed an evaluation framework that would recognize the different kinds of value that participants might derive from it. For this we chose the Value Creation Framework or VCF [11] as an appropriate test of the type of community of practice we were trying eventually to build [3]. The VCF collects data to document five cycles of value created in teacher professional development activities:

- **Immediate value** refers to activities and interactions that produce value in and of themselves, such as finding oneself in a community of like-minded professionals
- **Potential value** is the knowledge capital (learning) produced through engagement with the CoMOOC.
- **Applied value** is the value gained from applying what has been learnt to participants' own professional contexts.
- **Realised value** is the value for others that results from the application to practice – that is, improvements in learning in participants' classes, or their colleagues' improvements in teaching with technology as a result of sharing what was learnt in the CoMOOC.
- **Reframing value** is the redefinition of strategies and values through their new understanding, occurring both at individual and/or at institutional levels.

Our aim was to test the extent to which the CoMOOCs were sufficient to achieve the full range of value creation. We collected data from in- and post-course surveys, follow-up interviews (in the case of *Transforming Education in Challenging Environments*). These data sources are presented in Table 1 below. In addition, we supplemented these data with participant contributions to discussions and activities in the CoMOOCs e.g. posts to Padlets (digital pinboards embedded as collaborative learning activities in the CoMOOCs).

These contributions were analysed using a template analysis approach based on [1]. A structured codebook was development based on the VCF which was subsequently revised and developed through the process of data analysis of the three CoMOOCs.

Table 1: Numbers of survey respondents and interview participants per CoMOOC

CoMOOC	In-course experience survey responses	Post-course impact survey responses	Follow-up impact survey responses	Follow-up interview participants
Transforming Education in Challenging Environments	1025	735	–	24
Teaching Online: Be Ready Now!	–	2711	518	–
Blended and Online Learning Design	–	1150	–	–

5 Findings

5.1 Immediate value

Participants overwhelmingly responded positively to the social learning environment we constructed for the courses. FutureLearn prides itself on its social learning environment, based on Laurillard's Conversational Framework (CF) [6]. We also drew on the CF to co-design multiple social and collaborative learning elements in the CoMOOCs, adapting these to both platforms. For example, on Edraak, we pinned the discussion beneath the content units, and embedded collaborative activities using Padlet and Mentimeter (a polling tool) into the units. On FutureLearn, discussion already took place underneath the content steps, but we added links out to Padlets and Mentimeter. Across all three CoMOOCs, participants told us they valued these aspects of the learning experience highly:

> I found that participants want to share their learning experiences and also I think that this is very important for teachers as teachers work in isolation they close their doors in their classrooms so unfortunately rich experiences are not shared however MOOCs offer them this window (Transforming Education in Challenging Environments)
>
> Tools, templates and sharing made this course a fantastic learning experience (Blended and Online Learning Design)
>
> Reading other people's comments gives me sometimes answers to some problems or questions that concern me, and making my own comments helps me to have a more interactive learning experience (Teaching Online: Be Ready Now!)

Some participants preferred not to take part in the discussion (e.g. "Sometimes other people's comments are not helpful and waste time" (Teaching Online), and did not value others' contributions, but this was not the majority experience. For example, 74 % of participants on Transforming Education found discussion helpful or very helpful for their learning.

6 Potential Value

Participants of all three courses regularly commented about how much they had learnt during the CoMOOCs. For example, in Teaching Online, 80 % of participants reported that they were more confident about being able to integrate the six learning types from the Conversational Framework into their teaching. Participants commented in the discussions and post-course survey on the most valuable things they learned, e.g.:

> I became more aware of using modern technology and integrating it with the educational process, and I saved time and effort in distance learning (Teaching Online: Be Ready Now!)
>
> it helped me better understand what is out there in terms of the tools and practices of teaching and learning online… The hands-on nature of this course allowed me to gain some experience using some digital tools such as the learning designer. I have also gathered new ideas and tips on digital tools that will help me design my online courses (Blended and Online Learning Design)
>
> I am teaching through online and this course helped me to realize more about the students' background why some of them were not actively participating in the class (Transforming Education in Challenging Environments)

While participants' learning was visible, it was more important for us that they were able to apply their learning to their practice. The next section shows that they were able to do this.

6.1 Applied Value

Within the CoMOOCs, discussions were designed in such a way that participants were able to share how they were applying the ideas to their context. Throughout the CoMOOCs, comments indicated that participants were making connections with the content and their practice. For example, responses to a discussion in *Transforming Education in Challenging Environments* enabled us to see that the participants could understand concepts and apply them to the context of education in all manner of challenging environments around the world. For example, a teacher in Egypt shared how she was working with the family of disengaged students; a teacher in Brazil shared how she was delivering language classes for refugees; a teacher in the UK shared how exploring the impact of the economic climate on children in her class helped her tackle hostility to immigrants. In post-course surveys, teachers also described how they could apply the ideas to their teaching:

> I'm attempting to use participatory action research with a group of teachers in Myanmar to explore the ways in which they can improve their own well being, continue their professional development and seek out opportunities to use their education expertise to address Myanmar's education crises (Transforming Education in Challenging Environments)
>
> I work within the youth program at the United Nations Fund, the Syria office, so I will transfer information to the youth group that I work with, especially with the partner associations (Teaching Online: Be Ready Now!)
>
> I have learnt a lot about blended and online teaching and learning. I've learnt that in online teaching, we do not just lecture students, but we can rather engage them and make them collaborate with each other in order to be more active learners just like in F2F learning (Blended and Online Learning Design).

6.2 Realised Value

We designed the learning activities in the CoMOOCs in ways that encouraged the teachers to show how they are applying the ideas in their practice. For example, discussions invited participants to share their teaching ideas and learning designs. However, we rely on participants reporting back to us whether their own students' learning improved after they implemented the ideas, or their colleagues benefited from the ideas they shared from the courses. This data is the most difficult to access, principally because this activity occurs after the CoMOOC has happened and we no longer have direct access to participants. There were reports of realized value in follow-up surveys in *Teaching Online: Be Ready Now!* and *Transforming Education in Challenging Environments*, but teachers seem to prefer to share examples of what they learned or plan to do rather than examples of how their students have benefited. This may be because they do not have a research orientation to their classrooms. Or it might be that they do not believe they have something significant enough to report. Nevertheless, some participants were reporting that their students responded better in class after they implemented some of the ideas and that their colleagues were enrolling on the CoMOOCs themselves and implementing the ideas in their own practice:

Interviews with participants conducted sometime after the CoMOOCs are a more effective way of collecting this information because they allow for the interviewer to tease out concrete examples, and have yielded some excellent examples. For example, we have accounts of teachers who have shared the ideas with other teachers in organisations throughout the Middle East, Far East and South America. Some of this material has been published in [5]. However, we need a better approach to capturing real impact data like this at the scale that is commensurate with the number of participants.

As a way of working towards this, we recorded videos with teachers who had completed *Transforming Education in Challenging Environments* to create a step within the CoMOOC called "How Teachers are Using this MOOC". In the video, two teachers, Lea and Mariam describe how they have used the ideas to calm a child with challenging behaviour, and to advise teachers about the ways they could use technologies. We embedded a Padlet within the step to try to capture other examples, and teachers have begun posting there, e.g.:

> I learnt some tools: Padlet, Mentimeter, Kahoot!, etc. ... I practiced these tools while I delivered the training to teachers in Myanmar. Among these tools, I usually use Kahoot!, wheel of name for making some quizzes then sometimes I use the Mentimeter for voting. Most of my participants were happy and participated actively in the lesson and they didn't have a boring time. As a result of these, I am sure to utilize these tools in the future for delivering training and lesson planning.
>
> ...the course ... exposes us to realistic problems that we suffer from in our schools in our Arab world. In Egypt, we suffer from a very high density in the classroom, as well as a lack of material capabilities, which means teachers ... can use strategies that suit these numbers to achieve high efficiency and effectiveness in learning
>
> I used entertainment such as playing a game ... to learn English words, and I was impressed with their learning and their insistence on winning. Honestly, after using the technology I saw the development that happened in my class

By embedding the kinds of examples of realized practice that we are looking for, we hope to encourage participants to become teacher-researchers, following through their use of innovative practice with data gathering in their classrooms. Further work is required to find ways of collecting and curating these examples at scale.

6.3 Reframing value

Reframing involves redefining educational strategies and values. Participants in all three CoMOOCs gave us accounts of how they had changed their own approach as a result of their experience, as well as transforming how the approach taken by their institutions. The theories of transformative education in *Transforming Education in Challenging Environments* had a major impact on how participants approached education:

> When supporting the field workers of the NGO I'm working for, I can use the ecological system approach and the transformative approach to help the field workers working directly with the children to improve their approach to children's challenges solving, to analyze the education performance of the children and find out mitigating solutions (Transforming Education in Challenging Environments)
>
> Through the lens of ecological systems theory and transformative education, I am now more conscious of the kind of interventions that we would want to introduce in the project. (Transforming Education in Challenging Environments)
>
> I found it valuable to see how educators in a different part of the world (Lebanon) were meeting challenges. These insights can transfer to the country I work on, Myanmar. I am also involved in an international advisory group to a political group in Myanmar, and i will suggest that they take the course. (Transforming Education in Challenging Environments)

Another instigator of such change was participants' engagement with the Learning Designer tool, which was a tool we embedded in each CoMOOC as a way for teachers to represent and share their learning designs with each other. Participants told us that this had changed their approach to teaching and learning and were already or planning to share this with their colleagues, for example:

> ... the learning design[er] and some of the digital tools I've come across in this course could help me plan and deliver a workshop for teachers for my small education consulting company. (Blended and Online Learning Design – comments)
>
> i will benefit from the learning designer to plan my sessions and I will try to practice blended learning in my class (Teaching Online: Be Ready Now!)
>
> I'm particularly excited about the Learning Designer tool. It's really useful to have an overview of all the activities we plan for our classes and a good way to help our students to plan and manage better their learning process. (Blended and Online Learning Design – comments)

Many participants noted that their approach to online and distance education had been radically changed, for example:

> I used to think that distance education was not possible, and the course and training changed that (Teaching Online: Be Ready Now!)
>
> Because education has become an urgent necessity due to developments in circumstances, and education can be open to many countries and take experiences and knowledges from all cultures (Teaching Online! Be Ready Now!)

7 Conclusion

This paper has presented the Theory of Change underlying the CoMOOC model along with an evaluation of the different forms of value it has created for participants. The paper has shown that the CoMOOC model is effective in engaging education professionals in meaningful, social learning at scale so that teachers working in crisis contexts are able to learn with and from each other to build community knowledge together.

The CoMOOC model works because it eschews a top-down approach to education, which has been typical of MOOCs designed by university educators and based on university courses. Instead, researchers co-design the content with professionals, positioning practicing teachers as experts in videos and using their reflections to co-create the CoMOOC content. Social and collaborative learning activities are then designed around the content to support participants to engage actively and contribute their own insights from practice. This extends the collaboration to involve not just the co-designers but all the participants in the CoMOOC. A shared online space is created to include a global community of educators.

The co-design Theory of Change demonstrates that by engaging co-designers from the outset and developing content together based on their local knowledge, it is possible to achieve the necessary buy-in from co-designers to embed CoMOOCs within their existing practices. This results in a sustainable scaled up solution to reach many more educators to meet the global need for teacher training.

The CoMOOC model can thus help to address one of the biggest challenges facing us, that is providing quality education in the face of disruption caused by global crises. This includes the pandemic, but is not limited to it – crises are sadly a constant feature of contemporary life.

We propose that the CoMOOC model to reach and support professionals in other professional areas, such as medicine and health care, social care, engineering, construction and other fields where new practical knowledge is needed and participants will benefit from learning with and from each other. In this way, the CoMOOC model can speed up the learning that is required to address United Nations Sustainable Development Goal 4 (education) and all of the other UNSDGs.

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How to Detect At-Risk Learners in Professional Finance MOOCs

Step One

Julie Wasilewski, Mehdi Khaneboubi, and Éric Bruillard

Université Paris Cité
EDA, F-75006 Paris, France
julie.wasilewski@free.fr | mehdi.khaneboubi@u-cergy.fr | eric.bruillard@u-paris.fr

"Financial Analysis" is an online course designed for professionals consisting of three MOOCs, offering a professionally and institutionally recognized certificate in finance. The course is open but not free of charge and attracts mostly professionals from the banking industry. The primary objective of this study is to identify indicators that can predict learners at high risk of failure. To achieve this, we analyzed data from a previous course that had 875 enrolled learners and involve in the course during Fall 2021. We utilized correspondence analysis to examine demographic and behavioral variables.

The initial results indicate that demographic factors have a minor impact on the risk of failure in comparison to learners' behaviors on the course platform. Two primary profiles were identified: (1) successful learners who utilized all the documents offered and spent between one to two hours per week, and (2) unsuccessful learners who used less than half of the proposed documents and spent less than one hour per week. Between these groups, at-risk students were identified as those who used more than half of the proposed documents and spent more than two hours per week. The goal is to identify those in group 1 who may be at risk of failing and those in group 2 who may succeed in the current MOOC, and to implement strategies to assist all learners in achieving success.

1 Introduction

Despite being offered by reputable universities and validated with certificates, assessing MOOC participants' skills and their recognition can be challenging. Unlike traditional degrees, MOOCs do not confer formal academic credentials, making it difficult to evaluate the acquired skills even with certificates and badges. To address this, badges and micro-credentials have emerged as opportunities to recognize knowledge acquisition and certify skills, both professionally and institutionally, including the potential for academic credit [5, 12].

Micro-credentials, as defined by [16], encompass formation that spans multiple courses but falls short of a full degree. They are increasingly prevalent across various platforms and are referred to by different names such as certifications, specializations, or nanodegrees. These paid certificates consist of a series of independent or non-independent MOOCs, where successful completion of each course leads to the award of a certificate.

However, limitations persist for MOOCs and e-learning, besides the issue of certification, a recurrent issue in the MOOC is dropout. [13] found that approximately 10 % of registered participants actually complete the course. Dropout rates are prevalent across all online courses not just MOOC, [11] showed that they tend to be higher in online courses compared to face-to-face courses.

Numerous studies have examined dropout and failure in MOOCs, by trying to determine the factors that determine them. [10] identified three main categories of factors: student factors, course factors, and environmental factors. Student factors encompass demographics, motivation, and goals. Course factors refer to the design, implementation, and support of the course, as well as learner interactions on the platforms. Environmental factors pertain to external influences such as work constraints and supportive study environments. Course designers and researchers can directly address course factors to decrease dropout risks.

Learners in MOOCs typically juggle professional, personal, and family responsibilities, which necessitates available time to complete the courses. The interests and motivations of learners are closely tied to their own objectives [17]. Indeed, several studies have highlighted the link between the motivation of participants and the completion of the MOOC [3, 2]. Participant's motivation is an important aspect of learners.

Research on course factors has highlighted the increasing use of learning analytics to understand student behavior and predict at-risk students. Techniques such as logistic regression, decision trees, factor analysis, and neural networks have been employed for this purpose [21, 14]. However, despite the multitude of studies, no singular model has emerged as significantly superior [14].

Regarding forum interactions, participants' engagement can enhance their performance. Research on dropout and failure based on forum interactions has shown that individuals who actively use forums have a higher likelihood of success [22]. Moreover, forums might not provide a meaningful context for studying dropouts, as few at-risk students consistently participate. This emphasizes the importance of employing alternative methods to identify diverse dropout patterns [22]. [1] demonstrated that, in their context, factors observed in the first week of the course could predict dropout with 82 % accuracy.

Analyzing learning analytics allows for the classification of learners based on their platform behavior. These classifications reveal distinct groups of student trajectories. For instance, [9] identified four sub-groups: “Completing” learners who successfully completed most assessments, “Auditing” learners who infrequently participated in assessments, “Disengaging” learners who initially engaged but then decreased their participation, and “Sampling” learners who only watched video lectures for a few assessment periods. While these classifications primarily rely on behavioral data from the platform and remain relatively stable on a weekly basis, [20] found that demographic characteristics are linked to changes in student behavior and group dynamics within the first half of the course.

The aim of this article is to investigate the online behavior of learners in a French MOOC called “Financial Analysis” offered in 2021 as part of a program named International Certificate in Corporate Finance (ICCF).

We seek to understand how to support at-risk students in achieving success.

By examining the factors influencing dropout rates and exploring effective strategies to engage learners, this study aims to contribute to the improvement the MOOC and enhance the overall learning experience for participants. Understanding the dynamics of online learning and identifying successful approaches can pave the way for more effective educational offerings in the digital age.

2 Context

2.1 Micro-accreditation ICCF

The International Certificate in Corporate Finance (ICCF) is a certification offered through a partnership between *HEC Paris* business school, which provides the pedagogical content, and *First Finance*, a company specialized in professional learning and certification in finance, which implements the program. In 2013, *First Finance* launched the first MOOC in finance [6], which was followed by two other MOOCs in 2015, resulting in the creation of the ICCF program. The program offers two training sessions each year in March and October and costs 2950 €. French workers can use various public funding options for continuing education. To obtain the ICCF certificate, learners must complete all three courses independently and pass a final exam at an assessment center.

ICCF is composed of three MOOCs: Financial Analysis, Valuation, and Financial Decisions. These three courses have a similar structure: a prerequisite phase, four weeks of lessons released on a weekly basis, and a case study. Each week is composed of a new chapter divided into sections. A section is comprised of videos, quizzes, documents, and live sessions. Each course is estimated to require three to five hours of personal work per week. In addition to the MOOCs, learners can attend synchronous moments:

- a masterclass (once per course) takes place in presence and online, it's composed by a presentation by a reputed financial professional, and by a revisit of the concepts covered in the week.
- a meet-up (once per course) is for remote case study preparation sessions (organized two weeks before the submission of the case study), supervised by didactic tutors.
- an online live session (once a week) to revisit the concepts covered in the week's chapter, to correct the difficult questions of the week's quiz, and to answer questions from the learners.

These moments are recorded, and learners have access to the replays. The final exam is a quiz of 120 questions randomly selected from a database made of 2000 questions. If a learner fails at the case study a re-take may be offered. Successful completion of the three courses and the final exam allows students to obtain ICCF certificate.

2.2 Financial Analysis course

The MOOC *Financial Analysis* is the first part of the ICCF certification. A new chapter is delivered each week during five weeks and one assessment week. Chapters are organized in two parts: content with videos and documents and content with training and evaluative quizzes. The pedagogical content of the course aims to:

- Analyze the financial documents of a company (income statement, balance sheet, cash flow statement) in different strategic contexts.
- Construct and interpret the key indicators of a company's financial equilibrium.
- Carry out complete financial analyses independently.
- Make a relevant diagnosis of the financial situation of companies.

The validation of this course is achieved through the completion of a case study evaluated by peers. To prepare for the case study, participants can attend an online meetup with tutors. The case study and peer review are both mandatory.

Problematics: A dataset from the *MOOC Financial Analysis* has been extracted during a complete course done from September 2021 to December 2021. Based on this data we focused on understanding the behavior of learners in the course so that we could determine the common characteristics of failed students to be able to identify those at risk in future sessions. This article is a preliminary attempt to describe online behavior of learners in micro-credentials.

3 Method

3.1 Data

We have collected data from 875 learners in two forms:

- Variables produced by the Edx platform: time spent watching videos, number of videos viewed, quizzes 'scores and results.
- Declarative demographic variables: gender, age, nationality, level of study.

To explain and describe failure or success in the *MOOC Financial Analysis* we have used R software [18] to proceed to a Multiple Correspondence Analysis (MCA). MCA is an unsupervised algorithm permitting to explore the relationships between categorical variables. Similar to the Principal Component Analysis (PCA), MCA provides an overall view of the links between variables [7, 19].

Ignoring missing data can decrease the precision and bring strong biases in the analysis models. We used the *missData* R package to handle missing value by imputing missing data by proportions with the method of [8]. In addition, we performed a Hierarchical Agglomerative Clustering (HAC) to visualize clusters of learners based on their proximity.

3.2 Participants profile

The sample was composed by 277 females (mean = 36.2 years old, s.d = 8.3), 539 males (mean = 36.7 years old, s.d = 8.5) and 59 who did not respond to the gender question. They mostly came from Europe (63.3 %), Africa (27.5 %). 74 % of the learners have at least a master's degrees. All participants were registered at the beginning of the course and were French speakers.

4 Results

4.1 Influence of socio-demographic data on achievement

The influence of the socio-demographic variable on achievement has been made by searching for correlation between gender, age, levels of diploma and localization. A Pearson's chi-squared test does not permit to find influence of gender on success or failure ($X^2 = 1.08$, $p = 0.299$). Learners with a master's degree succeed more than the others but not significantly ($X^2 = 3.6$, $p = 0.05766$). However, learners aged between 35 and 45 years old (Figure 1), have a greater risk of failure than other age

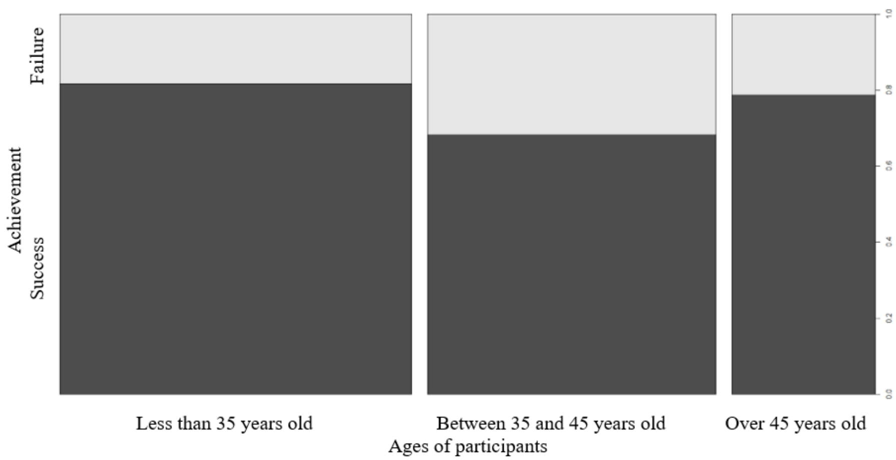

Figure 1: Frequency of results by learners' age

categories ($X^2 = 16.35$, $p < 0.001$). People living in Europe have a higher chance of success ($X^2 = 10.7$, $p = 0.005$).

4.2 Factors influencing success according to correspondence analysis

Data produced by the Edx platform have been recoded into qualitative variables:

- Completion of the quizzes (yes/no)
- Time spent on the platform (less than 1 hour, between 1 and 2 hours, more than 2 hours)
- Number of videos viewed (less than half, more than half, all videos)

Achievement's variable is produced at the end of the course and have two modalities: Success and failure.

The Figure 2 is a representation of learners according to their achievement, we observe a parabolic representation named Gutmann's effect occurring if there are multiple links between the variables [4]. This representation shows that individuals who failed the courses are grouped on the right whereas those who succeed are grouped on the left of the scatter plot. In between these groups, there are "at-risk" students who use more than half of the proposed documents and spend more than two hours per week.

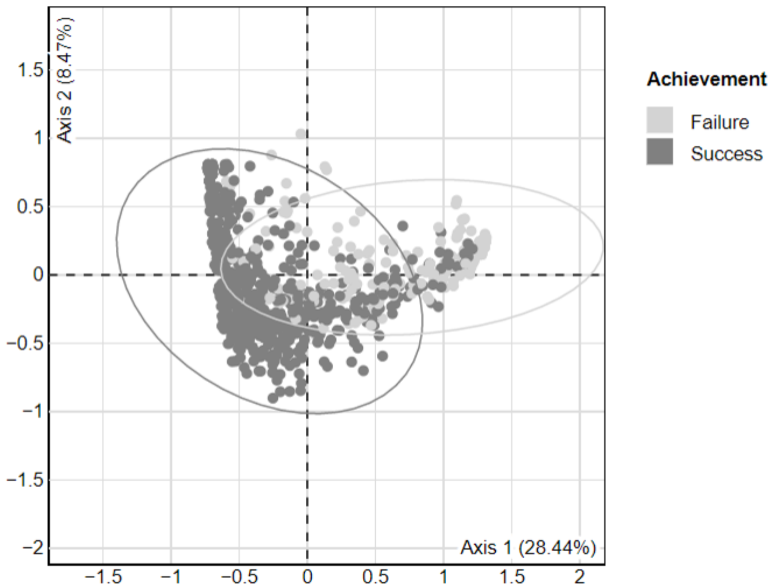

Figure 2: Representation of Individuals factor map (MCA)

The variable linked to the failure of the course are closed to the one not submitting the quizzes, not watching all the videos, and spending less than an hour on the platform during the first week of the course, while the variable identifying success is close to the learners who complete the quizzes, view all the videos and spend between 1 and 2 hours on the platform during the first week of the course.

To have a better view of the groups, we performed a Hierarchical Agglomerative Clustering (HAC). It allows us to have a more precise view of the clusters. The HAC produced a dendrogram, we decided to focus on a 3-cluster solution.

Figure 3 shows two main groups, the first one concern learners with a high tendency to fail. They share common characteristics:

- Not completing the weekly quizzes
- Watching less than half of the videos offered each week during the course.
- Spending less than two hours on watching videos on the platform during prerequisite courses
- Spending less than an hour on watching videos on the platform each week of the course.

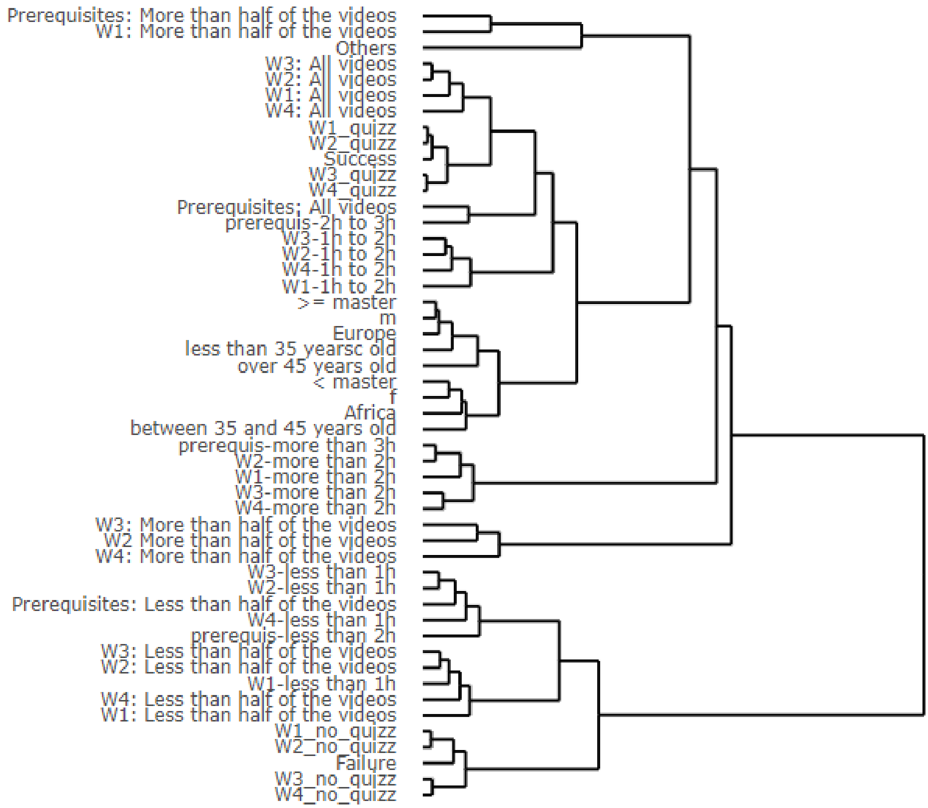

Figure 3: Classification of learners' achievement

The second one is people with a high tendency to succeed share common characteristics:

- Completing the weekly quizzes
- Watching all the videos offered each week during the course.
- Spending one hour to two hours on watching videos on the platform during prerequisite courses
- Spending one hour to two hours on watching videos on the platform each week of the course.

Between them, there are characteristics belonging to the same cluster of successful learners, but which are close to characteristic with high risk to fail. They share common characteristics:

- Spending more than three hours on watching videos at prerequisite course
- Spending more than two hours on watching videos each week of the course
- Not watching all of videos each week during the course

These results highlight that learners' early behaviors on the platform can indicate whether they will succeed or fail in the course.

5 Conclusion

We conducted an analysis of learners enrolled in the initial course of the ICCF program. Our analysis focused on various learner behaviors on the platform, including the time spent watching videos, the number of videos viewed, completion of quizzes, and course completion. The results revealed three distinct behavioral clusters. Cluster 1 consisted of individuals who successfully completed the course, demonstrated by high numbers of video views, completed quizzes, and spending one to two hours on the platform each week. Cluster 2 comprised individuals who failed the course, characterized by low levels of video views, completed quizzes, and time spent on the platform each week. Cluster 3 consisted of at-risk students who managed to succeed but exhibited similarities to Cluster 2, as they did not watch all the videos and spent more than two hours on the platform each week.

Interestingly, we observed that learner demographics had minimal influence on course success, contrary to previous studies [22, 15]. This discrepancy can be attributed to the fact that ICCF learners possess more homogeneous profiles compared to the general MOOC population which can be explained by the cost of this micro-certificate (2950 €) and its specific thematic on corporate finance.

We have been able to determine factors that can be identified at the beginning of the course, which allows us to detect learners at risk. We found that learner behavior on the platform during the early weeks of the course can serve as predictive indicators of their success or failure. These indicators enable us to determine risk profiles for learners. However, there are certain limitations to our research, as we were unable to ascertain the learners' specific objectives upon enrollment and whether their perceived failure aligned with their primary objectives. Nevertheless, previous studies [6] on the ICCF program have identified several objectives directly linked to their engagement and motivation, such as obtaining certification or expanding one's professional network. The success of these objectives requires the completion and success of the three MOOCs composing the ICCF.

Our next step involves analyzing data from other courses within the ICCF program to determine if similar patterns emerge and to develop strategies that promote success for all learners. We will thoroughly investigate the impact of success or failure in the initial course on subsequent micro-accreditation courses and explore whether the characteristics of at-risk learners in the first course remain consistent throughout subsequent courses.

Acknowledgment

We are grateful to First Finance and its staff for supporting this research by providing the data.

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A Retrospective Feedback of MOOCS in Morocco
What is the Best Scenario for the Moroccan Higher Education?

Souhad Shlaka[1], Sara Ouahib[2], and Khalid Berrada[1]

[1] Faculty of Sciences, Mohammed V University in Rabat
4 Avenue Ibn Battouta, B.P. 1014 RP, Rabat, Morocco
[2] Faculty of Sciences Semlalia, Cadi Ayyad University
Bd. Prince My Abdellah, B.P. 2390, 40000 Marrakech, Morocco

The integration of MOOCs into the Moroccan Higher Education (MHE) took place in 2013 by developing different partnerships and projects at national and international levels. As elsewhere, the Covid-19 crisis has played an important role in accelerating distance education in MHE. However, based on our experience as both university professors and specialists in educational engineering, the effective execution of the digital transition has not yet been implemented. Thus, in this article, we present a retrospective feedback of MOOCs in Morocco, focusing on the policies taken by the government to better support the digital transition in general and MOOCs in particular. We are therefore seeking to establish an optimal scenario for the promotion of MOOCs, which emphasizes the policies to be considered, and which recalls the importance of conducting a delicate articulation taking into account four levels, namely environmental, institutional, organizational and individual. We conclude with recommendations that are inspired by the Moroccan academic context that focus on the major role that MOOCs plays for university students and on maintaining lifelong learning.

1 Introduction

By following the path of foreign universities, the Moroccan Higher Education (MHE) is being part of a policy plan to normalize the integration of the digital transition as a potential lever of the great transformation of higher education. Being aware of the scope and the importance of the digital transition, MHE is committed, on one hand, to numerous projects and partnerships aimed at training and accompanying teachers and, on the other hand, providing the necessary means and resources to establish the development of this transformation.

Being aware of these changes, many academic initiatives have begun to emerge. The first experiences were mainly marked by initiatives taken by university presidents through the creation of centers dedicated to university professors, where they can design and develop online courses. The first university to be involved in MOOCs is the Cadi Ayyad University of Marrakech (UCA), that in 2013 created a "*Pedagogical Innovation Cell*", a very well-equipped center that provides the necessary equipment to design online courses (Computers, recording studios, software...). In this context, we mention the UC@MOOC project of UCA, launched in March 2013 with the creation of the http://mooc.uca.ma, a platform dedicated to online courses for students with totally open access.

In addition, in 2017, a partnership between the French agency "*Agence Universitaire de la Francophonie*" (AUF) and the Mohammed V University in Rabat aimed to train teachers on designing and implementing MOOCs and to support and encourage researches on topics related to pedagogical innovation and digital technologies. In fact, experiments carried out in the context of the cooperation between higher education institutions and the AUF, in particular by participating in the financing of scientific events on pedagogical innovations, have helped to set the stage for innovative digital practices in general and MOOCs in particular.

Also, the different national meetings known as "*Rencontres Universitaires du Numérique*" (RUN), which started in 2015 in Marrakech and were then held annually in several Moroccan cities, gave rise to the "*Maroc Université Numérique*" project, which was materialized by the creation of the platform "*Maroc Université Numérique*" by the Ministry of Higher Education, "*France Université Numérique*" (FUN) and the French Embassy. The purpose of this agreement was to set up a Moroccan white label platform to enable Moroccan universities to develop MOOCs and SPOCs or any other form of online courses.

At the same time, and with a view to promoting MOOCs and SPOCs within higher education institutions, a partnership under Erasmus+ was launched in 2017. The project involved 14 Moroccan and European partners in a consortium. The interest of the project was to pool the different experiences of Moroccan universities conducted within the framework of the MOOCs and SPOCs courses in a single national platform which will be accessible to a large number of learners/ students.

Reflecting on the above, it is obvious that there is a willingness to promote MOOCs in MHE. But the real finding is that the digital transformation is just beginning to emerge taking an important place in the higher education system. The report of the Higher Education Council [6] states that: "*What marks the current digital situation in the Moroccan higher education is the disparate nature of existing projects and experiments at universities that have developed, with their own means, internal digital environment applications and platforms*." (p. 69).

2 Covid 19: A Real Accelerator of Distance Learning

There is no doubt that the Covid-19 health crisis has challenged the effective integration of digital practices in education. On the Moroccan side, decision-makers have taken the opportunity to reinforce the digital education in the higher education scene, allowing a rapid and real integration of distance education.

2.1 A change of posture among teachers

Before elaborating on the various decisions taken by the government, it is crucial to underline the change in attitude observed among teachers. The adoption and implementation of digital practices in the university context is primarily a motivation act of teachers. However, and we quote here our experience of designing a SPOC within our institution at the Faculty of Science of Rabat (FSR), university teachers were very reluctant to take part in the SPOC experience. They have often expressed that they are neither interested in nor willing to change their practices, which they consider to be efficient enough to be replaced by new practices beyond their capabilities. Indeed, this reluctance is explained in their relationship to ICT, because they are not convinced of the pedagogical usefulness of these technological tools and only use them for pedagogical management and exam preparation [1, 12, 3].

However, this "forced" immersion, during the Covid-19, to use platforms such as MOODLE, Classroom, Zoom, Meet etc to ensure the pedagogical continuity has positively impacted the teachers to reconsider their practices and to open up more about what the digital transformation could bring to their pedagogy. For example, some teachers have maintained regular use of educational platforms such as Moodle and Classroom. In addition, requests for online course design, including MOOCs, has raised. We cite as an example: a call for projects launched in 2022 by the "*University Mohammed VI polytechnique*" (UM6P) to develop an or the online course (MOOCs). This project has succeeded, for the first time, in bringing all public universities together and in attracting teachers to join. This was demonstrated by the number of projects selected, representing 73 submissions from all the Moroccan public universities.

2.2 A more "open" ministerial vision

In July 2021, the former government established the legal framework for distance education. In fact, the regulatory text to set the measures and conditions related to distance education provided by framework law №51.17, has been adopted. The decree on distance education №2.20.474 stipulates the importance of developing distance education in addition to face-to-face teaching. The decree, composed of 18 articles, provides a precise definition of distance learning and its types by establishing a list of measures relating to the structuring and organization of distance education. Some of the statutory measures are:

- Teacher's training
- Creation of administrative structures for distance education
- Integration into training programs of introductory modules for the use of ICTs and computer programs in distance education
- Creation of a national committee and regional monitoring, development and evaluation committees
- Creation of studios, in particular in institutions of higher education dedicated to the production and recording of audiovisual digital educational resources according to current standards.

In the same vein, the current government relies on digital technology as an important pillar in the new architecture of the Moroccan University. Indeed, decision-makers have become aware of the urgent need to modernize the Moroccan university to be at the level of the so-called 4.0 universities. In the ministerial program, we talk about an open and connected university a "smart university" where MOOCs are an integral part of the Moroccan education system. The university is moving towards a learner-centered mode of learning that seeks to offer a faster training which is better and more accessible at a lower cost, in a more practical way and in a new approach that reconsiders time and space.

Thus, the University 4.0 highlights a hybrid pedagogy in addition to the face-to-face one, where learning is also done in a flexible and mobile way by MOOCs and SPOCs. In a testimony of the Minister of Higher Education, Scientific Research and Innovation, he calls for more openness to MOOCs by testifying to the observed benefits of the Moocs at the University Cadi Ayyad of Marrakech (Morroco). According to the experiences of Cadi Ayyad University, Moocs enable students to learn and comprehend a particular aspect of the course at their own pace, or to quietly prepare for the next course in person for improved communication with the teacher.

Indeed, this pedagogical choice becomes more persistent in an educational system marked by massification. It should be remembered that the human and material resources available in Morocco are not able to meet the needs of learners, so institutions must highlight a dematerialized teaching by MOOCs and SPOCs as an alternative to massification. In this sense, the Report of the National Council of Education states that "The Mass University creates new requirements and skills for the research teacher, such as teaching large numbers of students using new technologies… using new digital means to counter laboratory deficits, teaching students remotely and designing MOOCs." [6]

Thus, digital education can be a solution to massification insofar as the scheduling of distance courses could lighten the face-to-face ones. Replacing a lecture course that takes place in a crowded amphitheater, where interaction with the teacher is almost non-existent, with an online course developed in an active pedagogical approach, would increase the performance of students [8]. In fact, this new model of education would be aided by combining classic face-to-face learning with online learning, since it has been shown that students can learn more efficiently online, with an increased retaining rate of 25–60 % for online study versus 8–10 % in a physical environment [4]. This best performance will be possible thanks to the advantages offered by the online course (flexibility, freedom, time, unlimited viewing of videos… etc), allowing each student to consider learning at his own pace.

It seems clear that Covid-19 was a catalyst and a driver for the deployment of distance education. In his article [14], Michael Trucano discusses the importance of "tipping points" for the expansion of educational technologies. A reality we have experienced and which is perfectly applicable to the context of the MHE.

3 What Is the Best Scenario for Moocs in the Moroccan Higher Education?

From all the above, it is clear that Morocco has made considerable efforts to improve teaching practices related to distance education. This is reflected in the Ministry's ambitious policy. However, and based on our feedback as both a university professor and a specialist in educational engineering, the tangible implementation of these decisions has not been yet implemented. We are already in the middle of the 2022/2023 academic year and yet in our classes, no change has been observed. So, through this article, we are trying to create a scenario, which focuses on policies and learners, and which we think could make this digital implementation more concrete.

3.1 Policies

First, all the conditions needed to deploy innovation in the university education system must be taken into account. Each level must be articulated in a complementary hierarchical logic. Bédard and Pelletier (2004) (cited in the report [2]) are interested in these conditions. They highlight several organizational elements that, to give rise to innovations, require a delicate articulation between four levels, namely environmental, institutional, organizational and finally individual. Thus, in the following, we present our vision for an optimal scenario that draws inspiration from the Moroccan university context and can be applied in a national scale.

Environmental level: We have made it clear, above, that the government has put in place the foundations of distance education, on one hand through projects and partnerships with other countries and on the other hand through the adoption of laws and legal framework for structuring distance education. Nevertheless, it would be necessary to go beyond the texts on paper to translate them into concrete acts and decisions on the ground. All government actions must be implemented and made concrete.

In this sense, we propose the creation of a national official open platform that offers a rich and varied catalog of MOOCs that take into account the specific needs and expectations of Moroccan learners (disciplinary courses, foreign language courses, soft skills courses, etc.) as well as ensuring life-long learning for all. In addition, the government must allocate a budget assigned to the promotion of digital technology, in particular by funding projects led by research teachers. For its part, the Ministry of Higher Education must give accreditation to the trainings/courses that include MOOCs and SPOCs in their programs.

Institutional level: In the absence of a hierarchical will, teachers who are the real actors and agents of change within universities do not feel concerned or motivated to convert to digital. Thus, the institution must have a well-considered strategy for the deployment of distance learning [7]. Its role is to provide leadership in promoting the design of MOOCs and SPOCs. Partnerships with other institutions should be encouraged in order to share different experiences and create a competitive environment. In addition, funds dedicated to departments are also required to provide the necessary funding to project teams. The position of the Open University of Brussels, for example, in promoting MOOCs within its institutions testifies the commitment of the institution which has been reflected in actions such as "promote innovation in teaching and improve the quality of student learning, support the professional development of teaching teams in order to contribute to the dissemination of knowledge to a wider audience than the one of the university as a way to develop an open access and to study a new field of research in the field of education." [11]. It is certain that without the commitment of the institution, any personal and isolated initiative of the teachers will not lead to the expected results and risk being marginalized by the students.

Organizational level: For the organization component, the digital strategy must be accompanied and supported by logistical, material and human resources (equipped studios, a technical and techno-pedagogical team, etc.) [3]. Teacher training is a critical component that needs to be prioritized. This would create a framework to make them aware of the digital revolution and would open up the possibility of making them reconsider their practices while discovering new ways of teaching offered by the digital technology. For students, they must have access to the internet by ensuring a good network on campus. Morocco has, of course, put in place various strategies in collaboration with Moroccan telephone operators to diversify their offers in order to make the Internet accessible to the whole population, but it turns out that a lot of work remains to be done in this sector. In fact, statistics from the "The Global Information Technology Report 2016 – Innovating in the Digital Economy" (Table 1) reveal that Morocco is below average when it comes to individual usage. We can read that Morocco is ranked 60/139 concerning "Individuals using the Internet", 63/139 for "Household Internet access" and 69/139 for "School Internet access".

Table 1: The Networked Readiness Index: 6th pilla: Individual usage.

	INDICATOR	RANK/139	VALUE
	6th pillar: Individual usage		
6.01	Mobile phone subscriptions/100 pop.	42	131.7
6.02	Individuals using Internet, %	60	56.8
6.03	Households w/ personal computer, %	61	52.5
6.04	Households w/ Internet access, %	63	50.4
6.05	Fixed broadband Internet subs/100 pop.	94	3.0
6.06	Mobile broadband subs/100 pop.	93	26.8
6.07	Use of virtual social networks*	77	5.5

Since a lot of individuals, who can also be students, don't have access to Internet at home, it is then up to the institution to remedy to that problem. Indeed, "The institution's material support is then perceived as facilitating the implementation of the digital transformation when it is existing, and as an obstacle to the implementation when it is absent" [2, 3].

Individual level: the implementation of a successful digital strategy is primarily related to the motivation of the teacher to share his knowledge and to adopt a position of openness. Thus, strategies must be developed closely with teachers in order to involve them. Note also that the design of a MOOC takes an average of eight to nine months, which is not easily perceived and accepted by teachers. As a result, it becomes necessary to support the professional development of the teaching teams engaged in a MOOC project by the recognition and appreciation of the work by the hierarchy. Also, the integration of designing online courses as a means of promoting and advancing the visibility of courses in a national platform that would put forward the expertise of professors and create a competitive dynamic between institutions.

3.2 A student-centered scenario

We recommend that the integration of MOOCs and SPOCs into the universities' curriculum should be done in a learner-centered approach that takes into account the specificities of the Moroccan university students. Indeed, based on our experiences within the FSR, the new students need to be guided and assisted at every stage, especially in the first year that marks the transition from high school to university. Also, our students care more about the grade than the skills/competences. That is, they are interested only in the compulsory courses that will allow them to validate the module and they will not seek to go beyond what is requested by the professor. Given their young age, they have not yet acquired this awareness in relation to their academic developments.

Therefore, in the first year, the MOOCs/SPOCs must be integrated as mandatory and accredited courses, otherwise, the online course will always be perceived by students as a second category course, therefore, it would not achieve its objectives. In a second step, gradually from the third year of the "license cycle", the students will have grown and matured to understand the importance of self-learning and to seek information on MOOCs platforms beyond what is provided by the professor so as to enrich and develop their knowledge. This should also be enhanced by an official recognition granted by the university through the system of credits, certificates or micro-credentials allowing the validation of new skills. All these measures would be perceived positively by the learner who will be able to rethink his university experience and be eager to explore knowledge beyond the offer of his formal education. In this way, he becomes interested in learning in order to further improve his skills/competencies and then transfer them to his future career.

The integration of MOOCs and SPOCs has already proved its worth in the academic world [5, 11]. We cite in our context the example of our SPOC ITS course that was conducted in real-world with students enrolled in the FSR. The SPOC was scheduled for three sessions (2017/2018/2019), which brought our students closer together to better understand their relationship with the online course in general and with the SPOC in particular. The results obtained have revealed that the SPOC has positively influenced the motivation to learn, the engagement and the flow of students which has resulted in a better academic performance [13, 10].

4 Discussion and Conclusion

It is obvious that the Moroccan higher education has certainly succeeded in charting the path of the digital transition in the educational scene. This has been possible thanks to the adoption of decrees and legal texts underlining the importance of distance education as a complement to face-to-face teaching. These decisions have been structured and framed by a list of measures related to the structure and the organization of distance learning. The current new policy converges on the same strategy that paints a picture of a modern university where MOOCs and SPOCs will be part of the university of tomorrow. Note also that international cooperations, meetings and scientific events (symposiums, seminars, conferences, etc.) are actions that have made it possible to enhance the digital transformation and to bring together all efforts of stakeholders so that the digital technology is finally a lever for the development of higher education and the modernization of universities. However, there is still much to be done. What is currently missing is that this transformation reaches our classrooms so that it becomes part of our pedagogical practices in a spontaneous and obvious way. This would be possible if it is carried out in a top-down approach where each actor ensures its role in the success of this implementation.

Therefore, based on our experience, we are making the following recommendations: the first action *sine qua non* to the deployment of the digital transformation in the education sector is the investment in the IT infrastructure by devoting a budget dedicated to the implementation of the digital transformation, this will be achieved through access to facilities and the Internet within institutions for all students. Secondly, programming MOOCs/SPOCS training should be designed in such a way as to respond to the specific problems of the Moroccan students. This should be done in a student-centered approach aiming to support students in their learning and academic achievement. Third, the promotion of MOOCs should be conducted by supportive policies, through their institutional integration in the accredited programs. This would ensure credibility and follow-up by students and provide opportunities for sustainable models of lifelong learning. Fourthly, MOOCs should firstly be in a hybrid form in order to keep that physical contact with learners to gently get them to accept and appropriate the digital in their learning. For their part, teachers will need to be trained on digital tools and introduced to take advantage of the benefits digital brings in their teaching practices. The motivation of teachers must go through the recognition and appreciation of their work by the hierarchy, the integration of online course design as a means of promotion and advancement. In addition, national strategies must be conducted to encourage them to change their teaching practices so that they are more socio-constructivist and supported by ICT as a communicational, educational and learning tools.

Finally, while considering national guidelines on distance learning, MOOCs have the merit of being integrated into teaching-learning practices. It is time to carry out a major transformation of MHE, both nationally and internationally. MOOCs have the potential to strengthen face-to-face learning for students and make knowledge more accessible for lifelong learning. This spirit of sharing should cross borders to collaborate with other universities all over the world (e.g. integration with EduGAIN [9]). We can imagine an inter-African network allowing a student enrolled at the University of Moundou in Chad to follow a MOOC designed by a team from Mohammed V University in Rabat and *vice versa*. But the success of the digital transition can only be achieved through a real willingness to share and through efforts led in a collective synergy with the main objective of moving forward together.

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Preparing MOOChub Metadata for the Future of Online Learning
Optimizing for AI Recommendation Services

Max Thomas, Thomas Staubitz, and Christoph Meinel

openHPI
Hasso Plattner Institute, Potsdam, Germany
max.thomas@hpi.de | thomas.staubitz@hpi.de | christoph.meinel@hpi.de

With the growing number of online learning resources, it becomes increasingly difficult and overwhelming to keep track of the latest developments and to find orientation in the plethora of offers. AI-driven services to recommend standalone learning resources or even complete learning paths are discussed as a possible solution for this challenge. To function properly, such services require a well-defined set of metadata provided by the learning resource. During the last few years, the so-called MOOChub metadata format has been established as a de-facto standard by a group of MOOC providers in German-speaking countries. This format, which is based on schema.org, already delivers a quite comprehensive set of metadata. So far, this set has been sufficient to list, display, sort, filter, and search for courses on several MOOC and open educational resources (OER) aggregators. AI recommendation services and further automated integration, beyond a plain listing, have special requirements, however. To optimize the format for proper support of such systems, several extensions and modifications have to be applied. We herein report on a set of suggested changes to prepare the format for this task.

1 Introduction

In recent years, the number of Massive Open Online Courses (MOOCs) and MOOC platforms has constantly increased. So-called MOOC aggregators – tools that list the courses of multiple MOOC platforms on the basis of course metadata – such as Class Central [2] or MOOC List [14] are almost as old as the first MOOC platforms. The benefit of these aggregators for the learners is the wider range of offers on similar topics on different platforms. The aggregator serves as a one-stop shop. The benefit for the platforms is the extension of their marketing range to attract new learners.

Metadata is defined as *"data about data"*[1]. Hence, the metadata of a course provides information about the course itself, such as its title, instructor(s), a description, etc. Usually, the aggregators fetch the metadata of the courses from the respective platforms, which are mostly provided via an API. Generally, this process is fully automated to reduce the workload on both sides and make sure the offers are reliably up to date.

To facilitate the automated collection of course metadata, MOOC platforms, and MOOC aggregators had to agree on common metadata formats. These formats are not only useful to deliver the metadata from the platform to the aggregator but also allow the aggregators to implement search algorithms that enable the learners to quickly find courses matching their search criteria. Next to searching, learners can filter the courses efficiently using metadata.

As there are multiple aggregators, there are also many different metadata formats, often developed in parallel with little or no knowledge of each other. This led to inconsistencies among the formats and incompatible systems. Fixing this, and, in the long run, establishing a standardized format, not only in the MOOC domain but more generally for any type of online course, is the aim of several initiatives.

As of today, several standards for metadata formats are on the market. While this does not solve the problem of different formats yet, it helps to reduce their number. Most of the formats in question feature open documentation, which makes it – at least technically – easy to achieve compatibility among the different formats. It is important to note that in this context, we follow the definition of the Cambridge dictionary for the term *standard*: "a pattern or model that is generally accepted"[2], which includes formal standards (standards issued by an organization following a formal standardization process) as well as de-facto standards (a model or pattern becoming a standard by wide usage).

Examples of metadata format standards according to our definition above are DublinCore [6] and schema.org [22]. They provide a very general vocabulary and basic structure for any purpose without a particular focus. As these standards are so general, they are a perfect starting point for the standardization of a metadata format with a more specific purpose, such as the exchange of information regarding educational resources. Namely, the ISO 19788 series of standards (*Information technology – Learning, education, and training – Metadata for learning resources*) directly implements [11] and the *Learning Object Metadata* (LOM) published by IEEE [9] is based on DublinCore. It is noteworthy that LOM is also an underlying standard for SCORM (*Shareable Content Object Reference Model*) and its successor xAPI/Project TinCan [24].

[1] https://www.merriam-webster.com/dictionary/metadata
[2] https://dictionary.cambridge.org/dictionary/english/standard

In the realm of the *schema.org* based metadata standards, two derivates are of particular interest due to their importance in German-speaking countries. First, there is the *Allgemeines Metadatenprofil für Bildungsresourcen* (AMB) [20], which again describes a more general format for educational resources. It serves as the basis for the *Open Educational Resources Search Index* (OERSI) [19]. The second format is the MOOChub format, whose name is derived from the aggregator platform MOOChub [15]. This format has to be supported by all platforms that are interested to be listed in the MOOChub catalog. In contrast to the previously mentioned standards, the MOOChub format is specifically designed to represent MOOC metadata. Additionally, the *Digitale Vernetzungsinfrastruktur Bildung (DVIB)*[3] (formerly known as *Nationale Bildungsplattform* (NBP)) [4] and the Digital.Campus Bayern [3] have committed to support the MOOChub format. Having been involved in the development of this format [7] and due to its proven usefulness and widespread acceptance, we decided to enhance it and prepare it to also support the needs of AI-driven recommendation engines and learning path assistants.

2 Development of an AI-ready course metadata format

As previously mentioned, different standards for the exchange of metadata are available and in use. Furthermore, these standards range from very general to very specific formats. While the general standards often only set a basic framework, the specific standards build on top of the general ones, modifying them for their special purpose. This, on the one hand, guarantees compatibility at least on the very fundamental level of the general standard, and, on the other hand, allows to have a format that exactly fits the needs of its application.

The MOOChub format is a good starting point for the next steps in the evolution of metadata formats for online courses. It already covers the very specific needs of platforms and aggregators and specifically implements many features that are needed for a comprehensive description of a course. Furthermore, the changes and modifications do not touch the underlying standards and, hence, do not affect the basic level of compatibility.

So, why is it necessary to modify and change things, if the format exists and is widely accepted in its target area? The answer is that many of the surrounding conditions have changed. During and after the pandemic the need for (high-quality) online educational resources has increased massively [21]. Not only the demand for these resources has increased but also the supply. For example, the offer of available MOOCs has increased again after a period of moderate decline [23]. Furthermore,

[3]only available in German

the awareness of the importance of life-long learning is spreading among the responsible parties in industry and academia [8]. Particularly, *re-skilling* and *up-skilling* are important topics, particularly for the industry [17]. In this context, recommendation services and learning path assistants are proposed as valuable support tools for the learners to help them to navigate through the jungle of offers [12]. Particularly, the huge improvements in the area of artificial intelligence (AI) allow new approaches here [1]. Several publicly funded research projects are working on smart solutions for recommendation services and assistants. For the German-speaking countries, we need to name here the DVIB and *MarkEtplace foR LifelOng educaTional dataspaces and smart services provisioning* (MERLOT) [13]. These AI-driven systems, however, have different requirements and need to be supplied with more detailed metadata than it was required for simple search and filter algorithms, as we learned from the projects above.

When we talk about recommendation systems, we mean a solution that suggests courses to a learner with comparable content. This can include courses on the same level but also more or less difficult ones. More sophisticated recommendation systems might also take the learner's data into account. E.g. a learner dropped out of a certain course as it was too difficult. The system will suggest courses on a lower level. Or if the learner provides information about his or her linguistic proficiency, only courses in the respective language(s) will be suggested.

Learning path assistants (LPA) go even further. Not only a set of similar courses will be recommended but a whole series of courses of different content and difficulty levels to enable learners to go on a personalized education journey. Advanced training and retraining for new challenges in the job or a complete career change can be represented with a learning path provided by the assistant.

The MOOChub format currently lacks this particular information for recommendation services and learning path assistants. We identified a particular need in the areas: *field of study/topic*, *competency level*, *required competencies*, and *model interests of learners*.

We created a draft [5] of a revised MOOChub format on the basis of our observations. The revised format will be discussed in the near future to become the successor of the current format. The draft is published and open for comments. The above-mentioned missing information can be given in our proposed format. We will give insights into how we designed the data fields in the following. The fields are:

- Field of study (subsection 2.1)
- Competency level (subsection 2.2)
- Required competencies (subsection 2.3)
- Model of interests of learners (subsection 2.4)

2.1 Field of Study

The recommendation systems and the LPA both depend on reliable information about the field of study because it provides information about the course content. With this information, similar courses can be identified by recommendation systems. The LPA, on the other hand, will need this data to choose courses with topics lying on the learner's path.

For all fields, it is crucial to be machine-readable, because of their intended usage in AI applications. Therefore, the vocabulary must be standardized. And there are many standards describing fields of study (e.g. *International Standard for Classification of Education – Fields*: ISCED-F [10] or *Fields of Science and Technology*: FOS [18]) – maybe even too many. Hence, one of the challenges is to agree on a set of standards to be used. To that end, we will take a flexible approach that is first limited to only two standards and allows us to add further standards when needed by our partners.

For the implementation, it will be mandatory to provide the name of the field of study and the name of the standard or framework used. There will also be the possibility to add additional data, like a shortcode or alternative names. We used schema.org *EducationalAlignment* objects with slight modifications (a shortCode field was added) to facilitate that.

As an example, an excerpt from a JSON file is given below (based on schema.org/EducationalAlignment):

Listing 1: JSON example for educationalAlignment

```
"educationalAlignment": [
    {
        "alignmentType": "educationalSubject",
        "educationalFramework": "ISCED-F",
        "url": "http://uis.unesco.org/sites/default/files/documents
    /international-standard-classification-of-education-fields-of-
    education-and-training-2013-detailed-field-descriptions-2015-en
    .pdf",
        "name": [
            {
                "inLanguage": "en",
                "name": "Computer use"
            }
        ],
        "alternateName": [
            "use of computers",
```

```
            "working with computers"
        ],
        "shortCode": "0611",
        "targetUrl": null,
        "type": "EducationalAlignment",
        "description": "Computer use is the study of using
    computers and computer software and applications for different
    purposes. These programs are generally of short duration.
    Programs and qualifications with the following main content are
     classified here: Computer use Use of software for calculating
    (spreadsheets); Use of software for data processing; Use of
    software for desktop publishing Use of software for word
    processing Use of Internet"
    }
],
```

2.2 Competency level

Another information of tremendous impact on the choice of a course or its selection by an AI is the competency level or difficulty of a course. A course might be too easy or too difficult for certain people depending on their background and education. So this information can be used by the recommendation systems and LPAs. Recommendation systems can react to the learner's data (if provided) and LPAs can arrange courses about a certain topic by increasing difficulty. The recommended courses shall meet the learner's level and course series have to be ordered correctly regarding their difficulty. A rudimentary orientation like "beginner", "advanced", and "expert" (or similar) is good enough for manual scanning of the courses by learners but is certainly not sufficient for AI-driven services according to our partners designing such systems. AI will need a much more detailed set of competency levels following clear and standardized definitions of the levels.

As for the fields of study, it is necessary to implement the competency level attribute in a way that allows giving information about the level name and the used framework together with additional data. In contrast to the field of study, there is no final decision on which frameworks to implement. It is subject to current investigations. The *educationalLevel* from schema.org gave us the chance to use a self-defined term. Our DefinedTerm object provides the following fields to fit the requirements of an AI-based service:

- name: The name of the educational level according to the framework used (can be given in several languages)

- educationalFramework: The educational framework used
- shortCode: A shortcode for the educational level as provided by the framework
- alternateName: A list of alternative names for the educational level
- description: A description of the educational level
- url: An iri (internationalized form of uri, allows Unicode char set) pointing at the document describing the framework
- targetUrl: An iri pointing at a web node representing the educational level
- type: Labels the object as an "EducationalLevel"

2.3 Required competencies

Learning paths and recommendations of courses strongly rely on what a learner already knows and which competencies he or she has. It does not make sense to recommend a course about AI, which expects fundamental programming skills, to a learner without any experience in writing computer programs. A recommendation system can take this into account and filter only for courses, in which the prerequisites are fulfilled by the learner. An LPA, on the other hand, uses this information to build a learning path, since it needs to know, which other courses a learner has to take beforehand to another course. In other words, creating useful learning paths is only possible for an LPA, if the course prerequisites are known.

To implement this, schema.org delivers a *competencyRequired* field. As for the competency level, schema.org allows for a DefinedTerm here, too. The fields of our proposed DefinedTerm are the same as for the *educationalLevel* except that the *educationalLevel* itself can be given according to our definition above.

2.4 Model of interests of learners

Besides these hard-defined data, there is also the question of what the learner wants and what the learner's interests are. One approach to get this information is to ask the learners, but sometimes the learner him- or herself does not know, either.

Different projects trying to create recommendation services and learning path assistants use surveys, questionnaires, or conversations with chatbots to find out the interests of a learner. To score the interests some projects and organizations use the RIASEC model (also known as Holland Code) [16].

schema.org does not provide any suitable fields or attributes to represent the RIASEC model. That is why for this case we added an extension to the original schema.org. This does not cause any harm since an extension does not interfere with the original standard.

We propose a simple array of strings here. The input values to the array are limited by an enum to the respective letter representation of the category within the model. With this field, we can now tag courses to map them better to the learner's interests.

3 Conclusion

To sum up, we have shown that the MOOChub format is a suitable starting point but has still some drawbacks when it comes to providing a data model for training AI-based recommendation services and LPAs. We proposed the development of a metadata format for courses that fills the gaps and allows better consumption of the provided data by AI-driven services on this basis.

We have demonstrated how the addition of a manageable number of further fields to the original format can enhance machine-readability and thus the usage in AI-based services. It is our strong belief that our metadata format will greatly support recommendation systems and LPAs. However, we are aware that the evolution of education is not finished by any means. We will have a close eye on current developments to further enhance our format. Thus, the development of our new format is not the end but rather the next iteration in the development of AI-ready metadata formats for MOOCs.

Acknowledgment

Funding by the BMBF (German Federal Ministry of Education and Research) via the project HPI4NBP (16INB2029) is gratefully acknowledged.

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Student-Centered Re-Design of an Online Course with Card Sorting

How to quickly get a mental model of students

Michael Dietz and Dennis Roth

Lehr- und Kompetenzentwicklung – Technische Hochschule Nürnberg
michael.dietz@th-nuernberg.de | dennis.roth@th-nuernberg.de

"How can a course structure be redesigned based on empirical data to enhance the learning effectiveness through a student-centered approach using objective criteria?", was the research question we asked. "Digital Twins for Virtual Commissioning of Production Machines" is a course using several innovative concepts including an in-depth practical part with online experiments, called *virtual labs.* The teaching-learning concept is continuously evaluated. *Card Sorting* is a popular method for designing information architectures (IA), "a practice of effectively organizing, structuring, and labeling the content of a website or application into a structuref that enables efficient navigation" [11]. In the presented higher education context, a so-called *hybrid card sort* was used, in which each participants had to sort 70 cards into seven predefined categories or create new categories themselves. Twelve out of 28 students voluntarily participated in the process and short interviews were conducted after the activity. The analysis of the category mapping creates a quantitative measure of the *(dis-)similarity* of the keywords in specific categories using hierarchical clustering (HCA). The learning designer could then interpret the results to make decisions about the number, labeling and order of sections in the course.

1 Introduction and Motivation

The course is provided for master students in mechanical engineering at Nuremberg University of Applied Sciences since 2019 by the lead author. Further details of the course concept are described in broad terms in [1]. The teaching-learning concept includes an in-depth practical part where students learn about virtual commissioning and how to interact with the digital twin in online experiments, called *virtual labs*. Course material in the learning management system (LMS) *Moodle* accompanies practical exercises with problem-based learning as the teaching method.

section 1 introduces the context of our work. In section 2, we shortly describe the background of the method and provide further sources. In section 3, details of the data collection process will be provided and in section 4 the analysis and interpretation is described comprehensibly and in detail. Results and conclusions will be given in section 5. Finally, we provide suggestions for future work.

1.1 Present Structure of the Course

The challenges with the course are a wide range of topics to be covered, interdisciplinary skills necessary to achieve the learning objectives, and ultimately, mastery of a sophisticated industrial software environment being used. The initial course material in the LMS was split into two parts, with the first part providing basic theoretical knowledge and the second practical part, in which students would use the dedicated software environment and instruction materials to work on their practical exercises independently. After the initial execution, the course was restructured for the first time based on students' feedback. We changed two main sections with subsections to become *weekly* sections. However, *this* first restructuring was not satisfactory, as further student feedback revealed in the next semester.

The course started with an organizational part and progressed week by week through theoretical parts and accompanying practical parts. The theoretical part covers topics such as automation technology, system modeling, programmable logic controllers (PLCs), fieldbuses and network topologies. In addition to the text documents, there are also videos and Internet links to support the students and to serve as an aid to acquire the learning material autodidactically. The practical parts contains many exercises that the students are supposed to work on and usually their work is to be submitted as a written report or assignment based on a template. Also, with the help of so-called mastery tests, students should quickly become familiar with the course structure to find information themselves and upload their assignments in a timely manner. Figure 1 shows an overview for theoretical and practical parts and the order in which they are presented.

2 Background

"Everyone knows the phenomenon: some products can be used intuitively, with others you are constantly searching for the right functions and they never behave as you expect them to... in many cases, however, it is not because someone has not put ***enough thought into them****, but because the information architecture does not correspond to the understanding from the user's point of view"*, as phrased by [7].

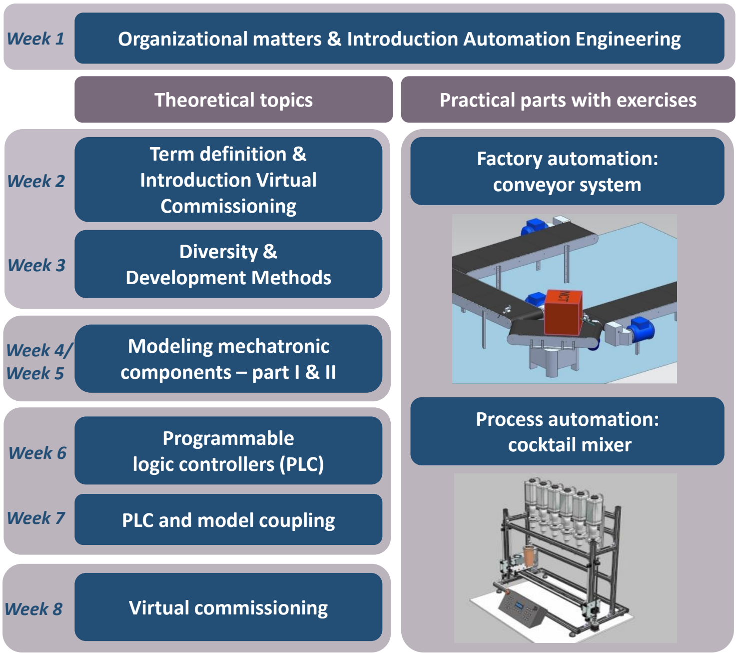

Figure 1: Theoretical content is divided in weeks, practical exercises run in parallel.

Card sorting (CSort) is particularly useful for learning designers creating courses in a LMS, where it is utilized to match designs to users' mental models, as described in detail along with more user-centered design and evaluation techniques in [12]. Since the users themselves are not able to describe their mental model, attempts must be made to obtain the necessary information indirectly as also stated in [7]. *CSort* is for Front-End-Analysis and a user experience (UX) research technique that has been used for several years to determine an information architecture. It was used already used in 1985 to organize menu structures [13] or user interface designs [9]. It involves asking participants to group and categorize information or concepts written on cards. This technique can help researchers to understand how people/users think about and organize information, as well as how they prioritize and label information. To conduct a card sort study, the researcher first creates a set of cards, each containing a single piece of information. These cards can be physical cards or digital cards in a software program. Participants are then asked to group the cards into categories based on their own logic or criteria. Once the cards are sorted, participants may be asked to label the categories they created and explain their thought process. In [3, 11] various card sorting research techniques are explained in detail, among them physical or digital card sorting, closed, open and hybrid and unmoderated and moderated testing. For further method description, please refer to the given literature sources. Figure 2 shows the process based on Mosers's User Experience Design [7].

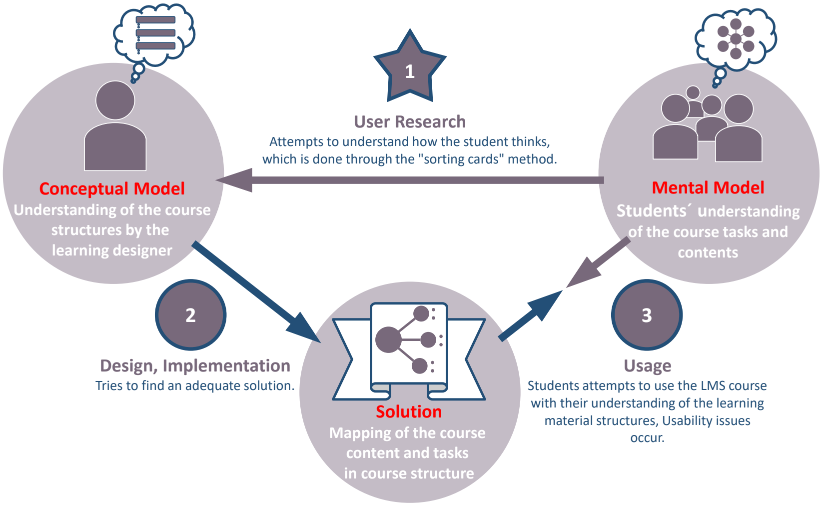

Figure 2: Simplified process in accordance with [7]

3 Methodology

A typical CSort dataset is structured as illustrated schematically in Table 1. Our approach uses several sources, firstly the related literature from section 2 and descriptions on the web, see [2] for a good start. It is suggested for beginners to

Table 1: Example of a nominal dataset with multiple participants in card sorting

Cards	Participant_1	Participant_2	Participant_3	...
Card 1	Category A	Category X	Category A	...
Card 2	Category A	Category X	Category X	...
Card 3	Category B	Category Y	Category Z	...
...	...	...	...	...

dive deeper into the following topics: *Hierarchical cluster analysis* [8] and *Distance methods* [4] and *Linkage methods*. Next, we will mention some critical aspects in brief. For our analysis, we used *complete linkage*, as shown in Figure 4 compared to other methods.

3.1 Performing an Hierarchical Cluster Analysis

We used the software *RStudio* to conduct a Hierarchical Cluster Analysis (HCA) using specific packages and functions which allows the calculation of the distance of nominal factors. The raw dataset has to be formatted to a CSV (comma separated values) file. By importing the dataset each card is represented by a number, which will later be used in the graphical output. Each step is shortly described next and in detail in the appendix on page 348.

A so-called dissimilarity matrix or item-by-item matrix with specified columns of the dataset is generated first, please note the different linkage methods further described in section 4. The dissimilarity matrix is used to execute the HCA. Next, the cluster analysis has to be visualized: a basic dendrogram is generated. A dendrogram is obtained by plotting the results of the HCA, which should further be graphically prepared. In Figure 4 in section 4, we show the resulting dendrograms generated using the different linkage methods.

4 Analysis and Results

This section is based on the recommended best practices for *"interpreting cluster analysis data matrices and dendrograms"* as shown in Righi et al. [11]. However, we only apply some aspects of their work that we believe are essential and helpful to the processing of our dataset.

4.1 Analysis of the item-by-item matrix

During the analysis, a number of data matrices and charts are created automatically or manually, depending on the tool chain used. The first one is the *item-by-item matrix (ii-mx)*, called disimilarity matrix earlier, which helps researchers to quickly find the most important relationships between each keyword in the card set. The *ii-mx* shows a percentage value representing how many participants have grouped each individual card with each other card in the set. One may look at the strongest relationships and ask *"What is the connection between these items?"*

First example: We start with two cards named *VPN connection (No. 8)* and *dongle license (No. 69)*. The dataset shows that 92 % of the participants put both cards in the same category. In fact, there is a close link here, as students need to connect to their institution's virtual private network (*VPN*) to activate their IP-over-USB *dongle license*. Every time students want to work on their exercises, these two steps are necessary. The second example shows two cards allocated to the same category by *all students*, giving a value of 100 %. These are, the so-called *PTn-Element (No. 65)*, a technical term from the field of control engineering and systems theory, and the *non-linear system element (No. 64)*, another term from the same field. As an important note, the underlying calculation process for the ii-mx starts with the highest similarity value and all other cards are calculated on this baseline. The given examples therefore explain the correlation of the items and thus also verifies the correctness of the underlying calculations that should lead to a high degree of similarity as suspected, further interrelations will be described in sections 4 and 5.

Similarity in percentages

Card no.	Labels	WinMOD	State machine	Timing functions, bit linkage, counters, memory functions	PTn-Element	Non-linear system element	VPN connection	Dongle license	Industry 4.0
61	WinMOD	–							
57	State machine	17	–						
55	Timing functions, bit linkage, counters, memory functions	17	58	–					
65	PTn-Element	33	42	42	–				
64	Non-linear system element	33	42	42	100	–			
8	VPN connection	25	8	17	8	8	–		
69	Dongle license	33	17	25	17	17	92	–	
28	Industry 4.0	0	0	0	0	0	0	0	–

Figure 3: Excerpt of an item-by-item matrix. The similarity indicates how many of the participants have sorted both cards into one category. Note that card no. are intended to identify items in the dendrogram in Figure 4

4.2 Analysis of the dendrogram

The *dendrogram*, also *dendrite* or *tree diagram* is "a visual representation of item relationships [and] is similar to that of a tree in that a large branch subdivides into smaller branches, each of which subdivides into still smaller branches, [. . .]

resulting in a hierarchy of categories and items" as phrased in [11]. As outlined in Kim and Bayes [14], *average*, *single*, and *complete linkage* have specific features such that e.g. *complete linkage* "...can resolve large clusters though it is highly influenced by outliers" or *single linkage* is "...sensitive to outliers but impervious to differences in the density of clusters". A first sight of the item-by-item and dendrogram representation is helpful for the process of creating the top-level categories for the redesigned course structure. Righi et al. refer to a slider function generated by card sorting tools for defining boundary lines to create categories.

In our work, we created the cut-off line manually, initially obtaining five top-level categories, see dendrogramm at far right and imagine the boundary line at roughly 90 %. Five categories are also highly consistent with the *"magical number seven plus or minus two"* by Miller [6]. Righi et al. now recommend returning to the ii-mx representation after defining the top-level categories and check that at least half to two-thirds of the rows have a high correlation with your categories, if this is true, one can proceed to the next step of our analysis. We used a potential top-level category *automation pyramid (AP)* that could best represent the card items. An AP depicts different levels in industrial production and classifies systems in control engineering. Unfortunately, there is no consensus on the naming and number of levels, so there are about 25 variants in the literature, as described in Meudt et al. [5] and it is challenging for students (and for researchers) which topics are related to the AP. Further, cards like *Cyber-physical systems (CPS)* or *hierarchical structure of productions systems (HSP)* where allocated in the same category. Table 2 does not show all percentage values, as it is intended to be understood only to illustrate the returning step to the ii-mx in the analysis. It was found that less than half of the similarity values were with high agreement (set to 50 %), Table 2 below. In that case Righi et al. state that participants may have very different mental models of how the content should be organized.

Table 2: ii-mx cells table representation indicating relationships

Card items	Field	Control	Process control	...	CPS	HSP
Field	–	50 %	67 %	...	25 %	17 %
Control	50%	–	42 %	...	25 %	8 %
Process control	67%	42 %	–	...	25 %	25 %
...	...	...	...	–	...	...
CPS	25 %	25 %	25 %	...	–	25 %
HSP	17 %	8 %	25 %	...	25 %	–

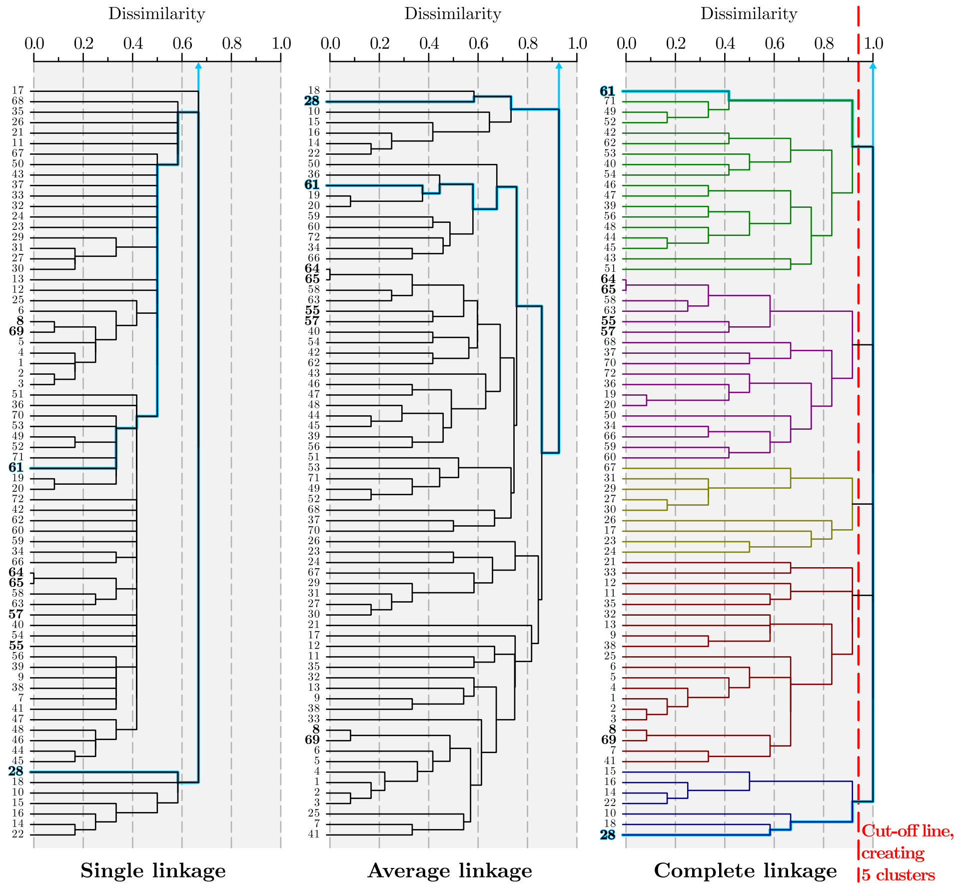

Figure 4: Dendrograms with different linkage methods, boldface card numbers correspond to cards from Figure 3. Depending on the method, the representation of the of the dissimilarity of two cards may be different, as shown in cards no. 28 and 61. Clusters are produced where the cut-off line intersects the dendrogram.

4.3 Label the Top-Level Categories

So far, it was decided to have *five* potential top-level categories, yet the names of the categories are still an open issue. This seems to be an extremely critical step, as it clearly affects the results and subjective naming can lead to non-optimal structure or usability of the course. To avoid this, we again followed Righi et al. [11], namely *Approach 1: Review the Items in Categories*. We started with seven predefined categories: Control Engineering, Automation Engineering, Modeling, Digital Factory, Digitization, Industry 4.0 and Other, working directly on raw data and focusing to:

1. Items that some participants grouped together but others kept separate
2. Cases where participants took different strategies for grouping items
3. *Miscellaneous* categories contain items participants didn't know where to put

Each case enforces specific actions for category labeling. Next, a selection of items is shown as an example how to find and label *suitable* top-level categories.

Case [1] will be demonstrated using items such as *Cyber-Physical System, Process control and Industry 4.0*. A simple text search in several tables of the raw data was used for this step. It could be found that, participants assigned these items often to different categories like *Other, Digitization or Digital Factory*. Yet, the categories ***Digital Factory and Industry 4.0*** were used more frequently. It was therefore decided to combine these two category names together for a single top-level category.

Case [2] focuses on cards about programming. Several cards were available for grouping and participants showed different strategies. One strategy was to combine cards related to the industrial software used in the course, namely for programming a PLC and for graphical programming in the software WinMOD. But eventually the idea came up to create a superior category where all other category assignments related to programming seem to fit in. A participant named it *Programs/Languages/Properties* and a simple internet search for wording options resulted then in the top-level category ***Types and Features of Programming Languages***, which covers to a large extent the required mastery of textual *and* graphical languages. For case [3] the search was for items that were assigned to the category *Other*. Items therein were e.g. *learning goals of the course, creating a screencast, write reports and use technical terms accurately, deepen understanding of technical terms through technical articles, definition of terms, use mindmap method*. Since these elements are clearly practice-based exercises, a category ***learning objectives*** to include all in one place was created. Lastly, brief interviews were conducted with participants after the CSort activity. Each was asked to describe considerations for category assignment and their individual course category sequence. Comments were also made on card items, such as cards that did not match well because they would fit into any or no category at all. Some suggested to divide the content between *physical world – the real production plant* from the *virtual world – the digital twin*. Lastly participants suggested combining *Control* and *Automation Engineering* or *Digital Factory* and *Industry 4.0* and *Digitization* categories together, which we also assumed when looking at the data as in case [2].

5 Discussion and Conclusion

This publication provided insights into an example of redesigning an online course based on empirical learner data. Our work shows how the method *Card Sort* can be used to create a mental model of students' information architecture to find meaningful clusters for learning content. The aim, generally speaking, is to derive a set of divisions and subdivisions of elements that lead to a reasonable information architecture. In addition, several valuable lessons were learned during the process, noting that the same result can be achieved by surveying students, but also that the use of data can contribute to objective structuring. A student who participated both in the course and card sort stated that *"the ability to create your own categories is extremely handy, as students can present their own opinions/contexts even better."* Regarding repeatability restrictions it is stated in [10] *". . . two card sort trials performed by the same participants. . . "* showed that the test-retest reliability was between 81 % and 95 % and that the open card sorting method has *"high test-retest reliability"*. These findings will be used for future work where further analysis is planned to improve the current results, to adjust for any inaccuracies, and to find and evaluate appropriate subcategories. This research is funded as part of the program "Strengthening University Teaching through Digitization" via the "Stiftung Innovation in der Hochschullehre" of the German federal and state governments [FBM2020-EA-2700-07250].

Appendix

First install the packages `cluster` for the `daisy()` function with the command in the software *RStudio.*

```
install.package('cluster')
```

To activate the package use `library()`:

```
library(cluster)
```

Importing the CSV file is done by the `read.csv()` function. With the option `stringsAsFactors=TRUE` we are able to use nominal data for the cluster analysis.

```
data <- read.csv('C:/My Documents/card-sorting.csv',
stringsAsFactors=TRUE)
```

By importing the dataset each card is represented by a number, which will later be used in the graphical output. The `daisy()` function is used to generate the dissimilarity matrix from the specified columns of the dataset, which we call `dm`.

```
dm <- daisy(data[,c('Participant_1','Participant_2',
'Participant_3', ... )])
```

The dissimilarity matrix `dm` is now used to execute the HCA with the function hc, which we defined as `hca`. Which linkage method is to be used in the cluster analysis is specified with the `method ='*'` option.

```
hca <- hclust(dm, method = 'average')
```

A basic dendrogram is generated from `hca` via the `plot()` function. With the option `hang` the vertical position, with `cex` the font size of the labels can be changed.

```
plot(hca, hang = -1, cex = 0.6)
```

By plotting `hca`, a dendrogram is obtained, which should further be graphically prepared.

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From June 14 to June 16, 2023, the eighth European MOOC Stakeholder Summit (EMOOCs 2023) was hosted by the Hasso Plattner Institute in Potsdam.

Fortunately, the pandemic has ended, nevertheless it highlighted the significance of digital education. Different countries faced unique challenges, and their responses varied.

EMOOCs 2023 focused on assessing the pandemic's impact on the development and delivery of MOOCs and e-learning across Europe. It explored successful digital learning models, the role of MOOCs and micro-credentials in business transformation, and whether pre-COVID routines were making a comeback or if new practices like remote work and hybrid conferences had become permanent.

Additionally, EMOOCs 2023 examined the formalization of digital learning, starting with micro-credentials and potentially evolving into fully online study programs or online universities. Another key theme was the integration of learning offerings and standardization of formats and metadata through initiatives like the MOOChub, the European MOOC Consortium, and the Common Micro-Credential Framework.

The conference included four tracks and workshops to share practical experience and research findings, covering various aspects of this field. This publication showcases selected papers from the Research & Experience Track, Business Track, and International Track at EMOOCs 2023.