colMOOC™

D1.3

Educational approach and framework

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The colMOOC:

Integrating Conversational Agents and Learning Analytics in MOOCs

D1.3 - Educational approach and framework

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Abstract:	This report will present all preparatory work carried out amongst the partnership in order to construct a high quality educational approach. Furthermore, the report will elaborate on the actual educational approach and presents all of its innovative features along with the reasoning of its mainstreaming abilities.

	This deliverable presents the instructional designs for each of the colMOOCs in response to the specific learning objectives and target audience. Moreover, ideas for instructional design and implementation of the conversational agent and learning analytics are being discussed.
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Executive Summary

This deliverable presents the instructional designs for each of the colMOOCs in response to the specific learning objectives and target audience. Moreover, ideas for instructional design and implementation of the conversational agent and learning analytics are being discussed.

Various MOOC designs that emerged recently are being illustrated in regards to their variation from each other while pointing out the main characteristics that all these courses have in common, which are massive participation, online and open access and the full course experience.

It goes on to describe recent trends in MOOC development and design, which incorporate focus on collaborative design, pedagogical agents, learning analytics, gamification, security aspects and system/instructor intervention.

For the design guidelines this deliverable provides a design timeline, guidelines for mooc videos, e-tutoring and quality management.

To exemplify these guidelines, descriptions of several MOOC courses are specified, both visually and written, by application of a particular graphical design language. This graphical design language is a useful tool to plan for the courses goals, participants and course expectations.

Finally MOOC task design and creation aspects are discussed and exemplified, regarding cooperative vs collaborative designs, openness of the task, task orientation and process implementation.

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List of Acronyms

Acronym	Description
CA	Conversational Agent
LA	Learning Analytics
LMS	Learning Management System
MOOC	Massive Open Online Course
OCW	Open Course Ware
OER	Open Educational Resource

1 Introduction

1.1 Purpose of this document

The objective of this deliverable is to present:

1. A detailed look at current MOOC designs
2. Information on current MOOC trends
3. Detailed MOOC design guidelines
4. colMOOC design descriptions
5. colMOOC task designs

1.2 Document structure

The present deliverable is split into five major chapters:

1. A detailed look at current MOOC designs
2. Information on current MOOC trends
3. Detailed MOOC design guidelines
4. colMOOC design descriptions
5. colMOOC task designs

1.3 Audience

This document is internal to colMOOC project consortium and to EACEA. It may be viewed by researchers and interested members of the public.

2 The prototypes of MOOC designs: cMOOCs, xMOOCs, and beyond

MOOCs made a splash in the media when the New York Times announced the Year of the MOOC in 2012, but they were already making waves in education in 2008. Two professors from the University of Manitoba, George Siemens and Stephen Downes, decided to create an online course on ‘Connectivism and Connective Knowledge’. They opened the course up to their own university students, and to anyone in the entire world who was interested in participating and over 2,000 people signed on. This first MOOC focused on building decentralized learning networks and joint knowledge construction. This form of MOOC was dubbed cMOOC or Connectivist MOOC (Margaryan, 2015). Within a few years a new form of MOOC arrived on the scene: the xMOOC. In contrast to cMOOCs, xMOOCs follow a strict linear format and participants primarily work independently of each other to reach their learning goals. One of the first xMOOCs, and arguably the first truly “massive” course was the 2012 course “Introduction to Artificial Intelligence” offered by Stanford professors Sebastian Thrun and Peter Norvig. The class had approximately 160,000 people enrolled from 190 countries. Almost immediately the potential of such courses became clear and universities and private institutions rushed to copy, adapt and expand on the MOOC format which has led to approximately 9,400 MOOCs offered and eighty-one million MOOC participants by the end of 2017 (Shah, 2018).

In the wake of x- and cMOOC, other formats of online learning have followed rendering any letter of the acronym “negotiable”. Most well known derivatives are SPOCs (Small Private Online Courses, which are often limited to an institutions own learners only), mOOCs (Mini Open Online Courses, which are similar to OER, Open Educational Resources in not featuring an entire curriculum), or ROOCs (Regional Open Online Courses with a regional appeal and language).

2.1 Models and variations

MOOC models are evolving quickly and, according to Siemens (2013), can be classified as xMOOCs, cMOOCs, and quasi-MOOCs. Following the naming trend of TEDx, MITx, etc. to indicate programs that are in some ways extensions of the core offering, Stephen Downes used the term xMOOC for programs that transfer online the traditional formal education model of an expert tutor and learners as knowledge consumers, with the use of saved video tutorials and graded assignments. While xMOOCs are an extension of classroom learning, cMOOCs can be seen as an alternative to traditional learning based on a Connectivist pedagogical model that views knowledge as a networked state and learning as the process of generating those networks, in this case using online and social tools. Lastly, the category of quasi-MOOCs encompasses a myriad of web-based tutorials as open educational resources (OER) that are technically not courses, but are intended to support learning-specific tasks and consist of asynchronous learning resources that do not offer the social interaction of cMOOCs or the grading mechanisms and tutorial-driven format of xMOOCs.

The main difference between xMOOCs and cMOOCs is that in cMOOCs the knowledge is being constructed (Rodriguez, 2012) and in xMOOCs, the knowledge is being ‘transmitted’ (Bernhard, Bittel, Van Der Vlies, Bettoni, & Roth, 2013). So, in xMOOCs, all the course material are predefined by the instructor. Some researchers have argued that these different models can address different learning needs. For example, Grünewald et al. (2013) suggested that xMOOCs are more appropriate for studying topics that can be learned through repetitive practice, while cMOOCs are better for developing higher-order creative skills. Daniel (2012) added that these two models should not be treated or assessed in the same manner. However, both models emphasize the importance of dialogue as a primary mechanism for maintaining connections during the learning process and as Bayne and Ross (2014) argued that the multiple pedagogic forms and intentions of MOOCs makes it difficult to categorize them under broad-brush descriptions and that the cMOOC/xMOOC binary may no longer be accurate or useful.

Although many MOOC formats exist, according to Glance, Forsey & Riley (2013) who made a sample of them in 2012, most courses exhibit common defining characteristics that include massive participation, online and open access, lectures formatted as short videos combined with formative quizzes, automated assessment and/or peer and self–assessment, and online forums and applications for peer support and discussion. In an effort to provide a working definition of a MOOC, the HOME (http://home.eadtu.eu), ECO (https://ecolearning.eu), and OpenupEd (http://www.openuped.eu) projects analyzed the MOOC dimensions of existing formats in the, arguably, ill-defined European MOOC landscape (HOME Project, 2015):

- Massive: Even though there is no precise number of enrolled participants to define the "massive" dimension, the basic notion is that enrollment far exceeds that of a typical classroom. Stephen Downes proposed the use of the Dunbar number (i.e., the cognitive limit of people with whom one can maintain stable social relationships – defined at approximately 150).
- Open: Ideally, a course can always be accessed by anyone, anywhere, as long as they have an internet connection. While this definition is valid for the vast majority of institutions, limitations usually exist on the age limit of the participants, or the time frame during which the course content is available (e.g., start/end day of the MOOC). Openness also refers to freedom of space, pace, and time, even though pre-defined pace and/or a fixed starting date and end date is not considered an explicit criteria to distinguish between MOOCs and other types of courses. Finally, the course is open to everyone without entry qualifications and can be completed for free. Additional services (e.g., remedial courses, accreditation, etc.) may be offered as part of the business model. However, participants should always have the opportunity to get a badge or a certificate of completion for free.
- Online: All aspects of the course (e.g., content distribution, learning activities, assessment, etc.) are delivered online.
- Course: The MOOC should provide a full course experience, equivalent to at least 1 ECTS (25-30 study hours). This includes access to a range of different learning material, opportunities for peer-to-peer and peer-to-teacher interaction and collaboration, individual/personalized feedback that could be automatic, or based on peers/teachers, assessment (either as a badge of completion or formal certificate), and a syllabus and study guide.

3 Trends in MOOC design

In this section, the trends in MOOC design are explored. For the sake of the colMOOC project, only the latest trends as well as those quite related to the project motivation and aims are discussed.

3.1 Collaborative Learning designs

Active learning pedagogies have been extensively studied at small-scale educational contexts (Järvelä et al., 2014; Tutty & Klein 2008). Such pedagogies aim to engage learners to develop collaboration, critical-thinking, and problem-solving skills. Collaborative learning (CL) is one common approach according to which learners are grouped in order to achieve a common learning goal through team effort (Dillenbourg, 1999). The literature has been informative in providing evidence regarding the positive effects of collaborative learning on learner performance and achievement (e.g., collaboration enriches learning with social and cognitive dimensions that maintain learner motivation and elicit verbal communication) (Roschelle & Teasley, 1995).

Several researchers have explored the use of collaborative learning in MOOC contexts as well, and thus far, the results have been promising (Ferguson et al., 2015). For example, Alario-Hoyos et al. (2016) found that collaborative learning activities promote social, active participation of MOOC learners, leading to higher academic performance. Blom, Li & Dillenbourg (2013) reached similar findings in a MOOC context, where weekly study groups were formed to enable learners to review and discuss the learning materials and vídeos with peers. Some other studies have focused on learners' preferences on the types of learning activities to be included in MOOC (Grünewald et al., 2013), and they identified a strong interest of MOOC learners in group discussions. One step to enforce collaboration was made from Barak, Watted, and Haick (2016) where they formed online learners groups to work and collaborate to prepare the final project. They indicated that learners that formed groups of four or five learners increased their motivation. Motivation is a crucial factor that affects dropout rate.

Ferschke, Howley, Tomar and Yang (2015) tried to utilize some of their insights and elements deriving from the field of computer-supported collaborative learning (CSCL) into their MOOC. They designed two types of intervention, a big help button available continuously to users and a chat room supported by a conversational computer agent. They found that learners constructed statements collaboratively and those two elements helped them. The collaborative chat component was also used by Tomar, Sankaranarayanan, Wang, and Rosé (2017). They also explored ways of orchestrating the peer matching into the chat room. The biggest problem they tried to solve is that access to MOOCs is asynchronous, meaning that every user may access it at different times, so they can access the chat component asynchronously. The results of their research were aligned with previous studies, meaning that learners that used the chat component had a positive impact on commitment to the course. They also found that the impact was bigger when learners used the chat component in dyads.

While these findings suggest the potential of collaborative learning at open and large scale contexts, attaining effective collaboration among MOOC learners is still a challenging task (Mackness, Mak, & Williams, 2010), as the massive scale and the open context introduce multiple difficulties in the design and implementation of collaborative activities (Dillenbourg, Fox, Kirchner, & Wirsing, 2014). As a result, so far, the uses of collaboration in MOOC contexts are still mostly pragmatically limited to peer reviews (Er et al., 2017), forum interactions (Brinton, Chiang, Jain, Lam, Liu, & Wong, 2013) or external social tools (Alario-Hoyos, Pérez-Sanagustín, Delgado-Kloos, Parada-G., Muñoz-Organero, & Rodríguez-De-Las-Heras, 2013), whereas only few research studies have focused on small group collaboration in MOOCs (Sinha, 2014; Spoelstra, Van Rosmalen & Sloep, 2014; Zheng, Vogelsang, Berlin, & Pinkwart, 2015; Wichmann, Hecking, Elson, Christmann, Herrmann, & Hoppe, 2016; Sanz-Martínez, Martínez-Monés, Bote-Lorenzo, Muñoz-Cristobal, & Dimitriadis, 2017).

There have been some research studies to support the design and enactment of collaborative learning strategies in MOOCs. With respect to design, among the few studies aiming to support the design process of MOOCs, Conole (2013) identified twelve criteria/dimensions that can be used not only to classify MOOCs, but also to plan their design. One of these dimensions was related to the extent to which collaboration is included in the course. In her follow-up work, Conole (2015) proposed a method to design effective MOOCs considering these twelve dimensions. Other research studies have focused on helping educators to address a variety of issues related to MOOC contexts (i.e., pedagogical, logistical, technological, and financial issues, and their relations) to describe and design MOOCs using a conceptual framework (Alario-Hoyos, Pérez-Sanagustín, Cormier, & Delgado-Kloos, 2014). Finally, ILDE (Integrated Learning Design Environment) (Hernández-Leo et al., 2014) is a platform that enable instructors to formalize learning designs in a computational way, providing advice and good practices for the use of collaboration. It also allows deploying these designs in learning platforms (such as Moodle). It has been used to deploy designs of several hundred learners in Moodle, but there is still no support for deploying courses on MOOC platforms such as Canvas or EdX, although it is part of ongoing research.

One of the critical issues to support large scale collaboration during deployment and implementation is group formation, monitorization and, if applicable, adaptation. Zheng et al. (2015) developed an algorithm to automatically form collaborative learning groups, in order to explore the effects of small learning groups on dropouts. In her thesis, Wen (2016) used natural language processing techniques to support the collaboration of suitable groups via the identification of learners that shown transactive reasoning in forums prior to the course. This may be particularly relevant to introduce the support of conversational agents to those learners without these skills, as intended in the colMOOC project. Different approaches were followed by Wichmann et al. (2016), who created homogeneous and heterogeneous groups of learners based on their engagement in the course and compared the performance of these groups, and Sanz-Martínez et al. (2017), who developed a tool to automatically create small groups of learners using teachers' criteria.

Concerning specific technologies to support collaboration at large scale, most existing tools are still in the research stage. For example, PyramidApp (Manathunga & Hernández-Leo, 2016) allows learners to carry out the same activity in successively larger groups, until a consensus of a large group is reached, by using this application from their smartphone, but checking their results reflected in the learning platform. The automatic conversational agents have been successfully tested to encourage collaboration (Tegos, Demetriadis, & Karakostas, 2015), and will be tested in the colMOOC project to play the role of facilitators of the discussion in order to promote in the learners advanced reasoning skills through the interaction with their peers.

Although several issues must be addressed in order to successfully integrate synchronous collaboration opportunities in MOOCs, the rich history of computer-support collaborative learning provides valuable insights, allowing the design of new MOOC affordances that promote fruitful peer interactions. Script-based collaboration has been established as one of the most popular approach to providing such affordances (Dillenbourg & Hong, 2008). A collaboration script can be regarded as a didactical scenario that aims to trigger and guide peer interactions through structuring and defining several aspects of peer collaboration (Weinberger, 2003).

In this context, researchers have found that well-targeted supportive interventions can be used as a method to increase the probability of constructive peer interactions taking place by means of stimulating cognitive processes such as conflict resolution, mutual regulation, or explicit explanation (Tchounikine, Rummel, & McLaren, 2010). Evidence suggests that conversational agents constitute one of the most effective ways to monitor small-group dialogues and deliver supportive interventions whenever appropriate (Adamson, Dyke, Jang, & Rosé, 2014; Kumar & Rosé, 2011). Considering that conversational agents were among the first technologies supporting dynamic scripting and have already proven to be successful within the field of CSCL, providing a vast potential for delivering precise and pedagogically beneficial interventions, one of our main aims is to explore their feasibility and impact in the context of MOOCs. We discuss conversational agents more in the previous deliverable (D1.2) of our project.

3.2 Pedagogical agents

According to MIT software agents group (2013), agents are "computer systems to which one can delegate tasks. Software agents differ from conventional software in that they are long-lived, semi-autonomous, proactive, and adaptive". Software agents can use artificial intelligence methods in order to analyze information and react to it.

The opportunities for using agents in e-learning courses are enormous. Agent characteristics like autonomy, abilities to perceive, reason and act in specialized domains, as well as their capability to cooperate with other agents makes them ideal for e-learning applications (Papazoglou, 2001). The potential use of several agents in e-learning environments has been researched many years before the advent of MOOCs, defining some potential roles for them like for example Pedagogical Agents (tutor, mentor, assistant), Web Agents (working with Internet applications and social networking tools), Learner's agents and mixed agents which could teach and learn (Jaques, Andrade, Jung, Bordini, & Vicari, 2002; Giraffa & Viccari, 1998). In MOOC environments, agents can be used to analyze data produced by the MOOC platform, systems and participants, and use it intelligently or mechanically to improve design, delivery and assessment (Daradoumis et al., 2013).

Considering the educational approaches described above, some applications of agents to MOOCs design and delivery could help identify potential problems, gaps and limitations of the initial course design, for example improper planning, improper distribution of course constituents, inadequate time assignment to the course different issues, errors in tests and evaluations, etc. (Guàrdia et al., 2013). Course managers can also receive information collected by agents that allow them to analyze the cost/effectiveness ratio of the courses, measure the quality of the learning offering provided, predict success/failure and drop-out rate of their learners and adjust their learning offer accordingly (Siemens, 2013). In addition, software agents could be used for real time analysis of content accessed by the participants, in order to detect potential problematic areas, solve some predefined detected issues automatically, enhance participants support and optimize the use of human support time by making them focus on the most critical issues (Bassi et al., 2014).

Agents can also improve MOOC assessment further. Agents can help define evaluation parameters that are personalized according, for example, to the participant's educational level, previous performance, etc. as well as design evaluation indicators that consider other parameters like peer-evaluation, social participation, creative thinking, problem solving, application of knowledge to a local reality, etc. (Glance et al., 2013). Agents can be used to improve testing methods in order to measure other achievement indicators, besides delivering automated tests. Finally, by analyzing usage parameters and content, agents can be used to detect potential cheating, such as plagiarism (Miguel et al., 2013), and alert tutors of sharing of critical evaluation content on social networks. Software agents can be used as part of the methods to validate the identity of a person, using, for example, typing patterns and face recognition (Bassi et al., 2014).

3.3 Learning analytics

Similar to any online course in a LMS, MOOC instructors also need to rely on learning analytics in order to have real time information about the learning process on the course, becoming a challenging problem due to the process of large amount of data. MOOC platforms handle hundreds of courses with hundreds of thousands of learners. For instance, Coursera has currently more than 25 million unique registered learners and more than 2000 courses (Coursera, 2018). Therefore, data warehouses should be ready to handle and process all the stored information (Bañeres, Caballé, & Clarusó, 2016).

Learning analytics support on MOOC platforms is being improved on each new release and the current analytical reports become a tool to analyze different faces of a MOOC course (learning resources, assessment, communication, collaboration, correlation among indicators, security, etc.) (Caballé & Conesa, 2018; Amigud, Arnedo, Daradoumis, & Guerrero, 2017). Literature reports on many innovation actions to provide specific case studies on MOOCs (Dennen, 2008; Romero & Ventura, 2010; Kizilcec, Piech & Schneider, 2013; Russell, 2014; Anderson, Huttenlocher, Kleinberg, & Leskovec, 2014; Halawa, Greene, & Mitchell, 2014; Khalil, Ebner, 2015; Klusener & Fortenbacher, 2015), which provide particular examples of analytical research by processing and analyzing data exported from the date warehouse of MOOC platforms and solve common questions arisen by instructors' needs, such as forum interaction, learning resources utilization, video playback, individual learner progression and retention as the most common concerns (Caballé & Clarisó, 2016).

In addition, some MOOC courses started to use custom learning resources, such as intelligent tutoring systems (ITS) to improve the learner experience in the course. For instance, an automated essay scoring is proposed in Balfour (2013) or CTAT (Aleven, et al., 2015) to support the creation of flexible tutors for both simple and complex problem solving (mathematics, thermodynamics, programming, etc.) while other courses have automated assessment systems with personalized feedback (Caballé & Conesa, 2018).

To sum up, learning analytics continues ongoing trends on interactive learning analysis to apply them both in traditional ITS and in the newly MOOC platforms, where interaction data is generated at a very large scale ("big data"). In this sense, learning analytics is built upon previous works (Romero & Ventura, 2010), in which the interactive processing of learning data has been analyzed exhaustively (Siemens & Baker, 2012). There are many results and applications in education in general and MOOCs in particular, such as providing effective assessment and automatic feedback to learners; supporting instructors by monitoring and predicting learner performance; and modeling user profiles for content and process customization, according to the learner needs, goals and individual skills (Caballé & Xhafa, 2013).

3.4 Gamification

Initially, MOOCs were seen as providing better education for all, offering the opportunity to study with the best teachers for free and promoting the development and management of specific learning communities for people with limited access to education (Rizzardini, Chan & Guetl, 2016). However, one of the most recurrent criticism of MOOCs is the high learner dropout rates (typically 85–95%) (Parr, 2013; Jordan, 2013). Among the main reasons for learner dropout are no real intention to complete, lack of time, course difficulty and lack of support, lack of digital skills or learning skills, bad experiences with user forums, poor quality or incorrect learning materials, and technical problems with the MOOC platform (Mackness et al., 2010; Yang et al., 2013). Three concepts are important in dropout research: (1) attrition is the "decline in the number of students from the beginning to the end" of the learning event; (2) retention is the "continued student participation in a learning event" and (3) persistence is "the result of students' decision to continue their participation in the learning event" (Berge and Huang, 2004).

Recently, gamification strategies have been used in educational models to engage learners through their intrinsic motivation. Hamari et al. (2014) argued that gamification could be used to support user engagement and to enhance positive usage patterns of services, like the activity of the user, the sociability aspect of services and the quality of the user actions themselves. Gamification is defined as the use of "game design elements in non-game contexts" (Deterding and Khaled, 2011). Burke (2014) said that Gartner defines gamification as follows: "the use of game mechanics and experience design to digitally engage and motivate people to achieve their goals." Gamification is different from creating an educational or serious game. While the latter is any type of game (a quest in a virtual world or a puzzle, for example) proposed with an aim that goes beyond pure entertainment (i.e. in our context, to promote learning), gamified application uses elements of games, such as leaderboards, badges, constant feedback, and points (Caballé and Clarisó, 2016).

These gamification elements can be used as powerful tools applicable in all sorts of educational contexts, and MOOCs are not the exception. Indeed, with the identified dropout issues in MOOCs, gamification is seen as a way to help solve the engagement issues and improve the completion rates of MOOCs. Consequently, during the last years, there is an increasing number of theoretical and empirical researches focusing on how gamification strategies could positively benefit to learner motivation and engagement in MOOC environments (Ortega-Arranz, Muñoz-Cristóbal, Martínez-Monés, Bote-Lorenzo & Asensio-Pérez, 2017; Antonaci, Klemke, Stracke & Specht, 2017a).

For example, Chang and Wei (2016) conducted an online survey to more than 5.000 MOOC learners to explore the relative-engagement levels of different game mechanics in such massive contexts. As a result, virtual goods, redeemable points, team leaderboards, "Where's Wally" game and badges were identified as the most engaging elements. Similarly, Antonaci, Klemke, Stracke and Specht (2017b) conducted a survey to 42 experts in the field of game design, learning science and technology-enhanced learning to identify the most suitable game elements and patterns for MOOC environments. Also, Ortega-Arranz, Kalz and Martínez-Monés (2018) have identified the "in-course redeemable rewards" as a very suitable and engaging game element for MOOCs based on the reported results from small-scale online implementations.

In the empirical field, Anderson et al., (2014) analyzed the effects of badges in discussion forums of a MOOC with more than 100.000 enrolled learners. Results show that forum participation and learner engagement significantly increased compared with previous versions of the same MOOC. In a representative experiment comparing traditional to gamified MOOCs (Rizzardini, et al., 2016), the gamified strategies applied reduced attrition of learners and improved motivation (78% learners were more motivated with these kind of activities). As a result, these gamification strategies had a good acceptance among enrolled learners, provided motivation in the delivery of assignments, and generated great expectation with regard to the rewards promised. Also, Cross, Whitelock and Galley (2014) analyzed the effects of badges in some collaborative and individual activities in MOOCs, showing that learners perceived badges as positive elements of the course although their motivation to earn them drastically decreased over the time.

3.5 Security

Among the MOOC design challenges that must be faced, poor grading, plagiarism and security vulnerabilities, such as anomalous authentication, become controversial issues for the academic community. Indeed, whilst MOOCs are easily and widely accessible, and as such typically succeed in involving a very large number of participants, anomalous user authentication cannot ensure that the actual identity of the MOOC learners is actually known in order to verify that MOOC learners are who they say they are or are instead cheating the system (Hill, 2013). Therefore, providing security approaches specifically to MOOC, and in particular effective learner authentication has been claimed by some authors as an essential feature in the MOOC arena, especially for evaluation, grading and eventual certification purposes (Miguel et al., 2013). For instance, course certification can make the difference for business models based on value-added services of MOOC that need the learner's identity is actually known and verified (Hill, 2013).

Current MOOC providers are very concerned about this user authentication issue and make great efforts to know and verify the learner identity during the MOOC sessions. For instance, they use biometrics (e.g. typing patterns) and other complicated mechanisms, which sometimes prove to be unreliable and are often privacy intrusive (Miguel, Caballé, Xhafa & Prieto, 2015; Amigud, et al., 2017). This also becomes a particular issue for satisfying accrediting institutions and hiring companies that rely on the emergent MOOC educational phenomenon (Tracey, 2013). Therefore, innovative user authentication methods for verifying MOOC learners' identity are required, so that the course progress and results are not compromised by either incompetence or malice (Miguel, Caballé, Xhafa & Prieto, 2015).

3.6 System and Instructor Intervention

As several studies emphasize (Agrawal, Leonard, & Paepcke, 2015; Almatrafi, Johri, & Rangwala, 2018; Chaturvedi, Goldwasser, & Daumé III, 2014; Kardan, Narimani, & Ataiefard, 2017), the fact that a large number of participants exist in MOOCs makes very difficult for the teacher to provide help or guidance. Because most of the learners seek help in course's forum, we focus our attention on how the system or the instructor can intervene in these.

Although instructors try to efficiently allocate their time in order to provide answers to as many questions possible, not all problems carry the same importance. Some of them are urgent, and some others can wait for a while before getting to instructor's attention. Almatrafi, Johri, & Rangwala (2018) tried to find a way to predict urgent posts in the forum that require immediate action from the instructor. They used linguistic features to score each sentence written in the forums and categorize each post into content or non-content category, and they reached promising results. A recommendation system also proposed by Kardan et al. (2017), who introduced a hybrid recommender system based on social network analysis. Based on previous actions a user took inside the forums, the system categorizes his experience and differentiate users that seeking an answer to their problem and users that are familiar with the topic. Moreover, the system tries to discover similar to the current topic threads. The primary target of the recommender system is to recommend relevant threads to users that are seeking help, reducing the time needed to get the answer. Recommender system also proposed by Yang, Piergallini, Howley, & Rose (2014). Their system aimed to provide users a short list of threads that they believe learners will find their answer.

Following previous studies, where system intervention by using recommendation was concerned, Chaturvedi, Goldwasser, & Daumé III (2014) focused on instructor's intervention in MOOC forums. They reported instructors' real intervention on some threads combined with the system's recommendation for the instructor, and they found an entirely high correlation meaning that their system could predict which threads need immediate response by the instructor.

Instead of a thread recommendation, a system could also propose another source of information where learners can refer to find assistance to their problem. Agrawal, Venkatraman, Leonard, & Paepcke (2015) presented YouEDU, which is a course video recommendation system. The first step of the whole procedure is to classify forum posts across multiple dimensions such as sentiment and urgency. The second step is to provide to posts that were characterized as confused from the first step, a reference to minute-resolution clips from the videos of the course. The recommendation system then gives the learners a list of the course videos that match their question by also providing specific start minute of the video. Results showed that in 74% of the cases, the first recommended video of the list was the proper one to find the solution to their answer.

4 MOOC design guidelines

Relatively independent of the instructional design of any respective MOOC, several design guidelines, from general recommendations to practical manuals have been formulated based on reviews of existing MOOC studies and experience of MOOC producing organizations. Regarding general recommendations, Pilli & Admiraal (2017) have concluded their review on MOOCs with the following advice:

- Ensure that all learners with different personal and academic characteristics are able to follow the course information. Conducting need assessment could be helpful to identify the learners' needs, preferences, and expectations as a basis for organizing course design. For instance, learners who have prior experience with online learning might be more active and ready to participate in open online courses compared to those who have no or limited experience.
- Course resources and tools should encourage learners to participate. These may include social networking tools, authentic tasks, project-based assignments, and collaborative projects.
- Providing unique features (e.g., authentic e-learning activities) within the courses increases learners' commitment and participation.
- Use peer and self-assessment for formative evaluation in conjunction with rubrics or other form of guidance to improve both learners' learning and the accuracy of their assessments.
- Provide clear and structured assessments, and design the assessments by taking into account the learners' profile and preferences in order to capture the learners' attention.
- Ensure that feedback is personalized and contextualized to stimulate learners' participation and engagement.
- Facilitate learner-centered communities using group projects or collaborative study groups to encourage learners' participation and engagement.
- Provide opportunities for learners to contribute in discussion forums and blogs in order to sustain their motivation to participate and complete the course.
- Ensure that MOOCs are prepared based on a well-structured instructional design models that include learning tasks, quality materials (e.g., videos) and tools, SNSs, aligned assessments, and personalized learning environments.
- Provide opportunities for learners to manage their own time in order to develop their intrinsic motivation and commitment to the course.
- Ensure that the duration of the course is no longer than 8 weeks; learners tend to remain in and complete shorter MOOCs.
- Provide alternatives for learners to accredit MOOCs to increase the retention. There should be an option to transfer credits from MOOCs into institutional degree programs.
- Foster self-directed learning environments to expand learners' autonomy, encourage them to complete their weekly assignments, and provide opportunities for learners with limited computer and language skills.

Turning to practical considerations, designing, developing, and conducting (and evaluating) a MOOC can be a major endeavor that requires careful planning including reflection on some typical misconceptions and disregarded aspects:

- **A classroom experience cannot be replicated online**. Even if you are covering the same information in a traditional class and in a MOOC the teaching and learning experience will vary considerably. Instructors should be aware that planning and executing a MOOC looks very different from traditional teaching.

- **Everything takes longer than imagined**. Instructors tend to underestimate the amount of time it takes to produce a MOOC one estimate has MOOC preparation averaging at 400 hours per course and three times the amount of effort compared to a traditional course (Mesquita 2015). In particular, instructors underestimate the time needed to produce learning videos. Depending on your experience and available resources, it is reasonable to assume that you will spend around three hours producing ten minutes of video.
- **Be aware of interdependencies**. Make sure that all resources referenced in videos are available when and where you say they will be. For example, if a reading is mentioned in a video the link to that reading should be immediately available and easily located. If for some reason the reading has been removed from the course plan then the video should be edited to remove mentioning the text. Otherwise learners will become frustrated looking for resources that are not actually provided. Additionally, make sure that the connections and sequencing between modules and lessons is clear and well defined.
- **Take technological limitations into account**. According to the feasibility study internet penetration ranged between 50 and 70% and most individuals used a mobile device to access the internet. Additionally, some of the target audience members (such as single mothers in Malaysia) report having limited or no technological experience. In these cases it is extremely critical to provide learner guidance and be aware of accessibility issues.
- **Complete the entire course and a quality review before going live**. Although it is tempting to continuously add to an existing MOOC in order to shorten release times, once a MOOC is running it becomes increasingly difficult to make changes and adjustments. Therefore, it is best to complete the MOOC in its entirety and review it from several perspectives (Design, content, coding, accessibility etc.) before the initial launch.

4.1 A timeline for MOOC design

Establishing a timeline for designing and developing the MOOC can follow along classic instructional design approaches, which entails setting the parameters, such as learning goals, and clarifying the target audience. With MOOCs affording a number of competencies, from expert knowledge on the domain, instructional design, technological support, and creating multimedia material, especially explanatory videos, human resources and equipment to realize a MOOC have to be identified well in advance in addition. MOOC design often starts out a year in advance to roll-out depending on existing resources. For novice MOOC designers, selecting and familiarizing oneself with a MOOC platform and provider is a first step in addition to setting parameters, gathering resources, and putting together a MOOC team. Following a recommended timeline (Kruse & Schulze, 2016), at least half a year in advance, learning goals should be established, course content should be organized - including creating slides and a video plan, and learning activities including assessments should be planned. At least four months prior to roll-out, promotional material should be created, filming should start, and the platform should be readied with tools for assessment and activities prepared. These activities and products (films, assessments, transcripts) should conclude at least two months prior to the starting date and promotion of the course should be intensified. One month prior, a quality assurance check should take place including a heavy duty technical test, any needed changes should be made, and promotion continue including sending out reminder emails and invites.

4.2 Filming MOOC videos

Most MOOCs are heavily reliant on video recordings and there are numerous ways to style learning videos, including: speaking directly to the camera and superimposing images later, audio voice over of a slide presentation, presenting in front of a white board or tablet, animations, and screen capture. Other formats include interviews with experts or with clients as well as models of how to do a task in authentic environments. This depends on the set learning objectives - focus on skills versus focus on knowledge, for instance - and how appropriate a video style is for the chosen topic. While there is a notion of MOOC teachers having to live up to Hollywood standards, recordings with lower video quality may convey authenticity and have not been a cause of concern after all. The audio recording, however, should be of the highest possible quality - from clear and slow speaking to ideal recording equipment - and may be additionally supported by a full transcript, which - different from many face-to-face lectures - is recommendable for the actual taping anyway. There is large agreement on keeping video segments brief, i.e. not exceeding 10 minutes, for meeting learners' interest and capacity, while the segments build up on each other. To break down the material into chunks that can be explained in five to ten minutes, learning objectives and course outline can be used for orientation. Visuals, such as slides, or animation should correspond with the respective learning objectives. Minimalistic slides, with little text, work best as many learners will view them in a reduced size and quality. Once the videos have been produced, they need to be made accessible to all learners within the respective platform by including closed-captioning, alternate text for images, and making all materials available for download and use offline.

The materials used in the videos or for download should be open source. Since MOOCs are open to anyone, many items that are available for classroom use at not available for use in a MOOC. This necessitates a check for the respective copyright status of all material that are to be used. Furthermore, functioning of links has to be checked for learners being able to download for offline viewing.

4.3 E-Tutoring a MOOC

Since learners cannot ask questions in real time it is important to provide complete clarity within the MOOC. Beginning with, and constantly referring back to, a syllabus with a course outline can go a long way in keeping learners informed. This document allows learners to have the most important information gathered in one place. The syllabus should include the grading policy, deadlines, and course expectations. Activities should be prefaced with clear instructions as to the expectations for that particular activity and an explanation as to how this activity helps them meet learning goals. Navigation should be clear and easy to use allowing learners to quickly reach the page or information they are looking for. Finally, learners should have a set and easy way to reach out for help if needed, whether this is then the discussion board or help desk ticket.

Likewise, course communication should be clear and may be planned ahead of time in spite of occurring mainly once the course has begun.

Email communication can be facilitated by an email distribution list, which can be produced from the registration information and used to keep in contact with learners. Sending the following Emails is good standard in most MOOCs:

- **Course Reminder Email**: sent at least one week before the course launch to build anticipation and excitement
- **Welcome Email**: sent on the first day of course including an introduction to the course and the team. This is a good opportunity to gather data about participants in a short

survey. This data can later be used to help learn about participants and measure the success of the course.

- **Weekly Updates**: summarizing the most important information from the week and preview what is to come in the coming week
- **Course completion Email**: summarizing the experience, thanking learners for their participation and outlining next steps including a timeline for receiving certification if applicable. This is a good opportunity for a post-course survey to learn about the strengths and weaknesses of the course.

Additional means of communication are the landing Page, which is the first page that learners see when entering the course and it should be friendly, welcoming and most importantly informative, keeping learners up to date with the latest course-related news and status reports.

Furthermore, a discussion board is where learners interact with each other and the instructor. The board should be clearly organized, and tasks should be distributed. For example, answering logistical and technical questions could be separated from answering the content questions.

Depending on the role of learner interaction, rules of conduct should be presented, e.g., for how to constructively conduct a peer review, and an escalation plan should be made for what to do in the case of an offensive or inappropriate post. This plan should include how and to whom learners can report such a post and what are the consequences for the learner responsible for the posting.

4.4 Evaluation and Quality Assurance

MOOC evaluation is integral part of the overall design process in building on the respective design models and criteria. In addition, MOOCs need to be reviewed along a set of practical and technical aspect:

- **Review for Content**: The instructor should be very familiar with the course material and review for any errors in content, including calculations and typos. The instructor should also make sure all complex terms are clearly defined and answers to questions are correctly coded.
- **Review of Platform functionality**: A team member familiar with the platform should check to make sure all navigation functions work correctly, all links are live, all items are labeled, and assessments operate correctly.
- **Review for Grammar and Detail**: Ideally completed by a native speaker of the course language. Identify and correct any typos, spelling/grammar errors, and check for consistent formatting.
- **Review for Accessibility**: Ideally completed by a team member who is NOT a native speaker of the course language. Identify and clarify any idioms or vocabulary that is unlikely to be familiar to international learners and check to make sure basic accommodations such as closed captioning and alternate image text function properly.

To assure quality, at least one beta tester should be established to review the course from the learner perspective in its entirety. With MOOC platforms having different server requirements, this should extend to and include loading times in addition to the criteria mentioned above.

5 colMOOC Design Descriptions

Based on the design guidelines presented in section 3, the consortium develops a variety of MOOCs for learners of the Humanities as well as employees and the unemployed to develop digital competencies that have not been covered in basic, mono-disciplinary studies. The "colMOOCs" will aim to capture the interest of different target groups and develop transversal digital competencies in specific fields. The consortium aims to develop three pilot MOOCs:

5.1 Programming for non-Programmers

Programming skills in the 21st century have become significant also for non-programmers, that is, students and professionals who do not major in programming but need to develop basic programming skills as a toolset for advancing their study, research and deeper understanding of their specific scientific field. The "Programming for non-Programmers" colMOOC course promotes a 'toolset' approach to programming, familiarizing learners with key computational ideas and Python-based programming patterns necessary to operationalize scientific problem representation and solving.

5.2 Computational thinking

Computational thinking is a systematic and creative approach to problem solving. It involves analysis and formalization of complex problems, understanding and developing feasible, technical solutions, as well as divergent and convergent ways of thinking.

5.3 Educational Technologies in the Classroom

New technologies enhance learning through dynamic, interactive, multimedia formats in simulations, web-videos, and games. Advanced technologies enable new forms to aggregate and visualize data for feedback to learners and teachers.

These three topics aim to capture the interest of university learners, but also serve lifelong learning addressing employed and unemployed adults. On one hand, this calls for innovative designs involving collaborative learning arrangements and formative feedback, not only to improve learners' performance, but also to minimize chances of dropout and to foster engagement. On the other hand, the three different topics and target groups call for tailored designs in respect to how learning tasks can be designed and implemented that open up a room for debate for learners to engage in discussion and collaboration (see table 1).

Table 1. Overview of goals, participants, and overall structure of the three MOOCs

	Goals	**Target Audience**	**Structure**
Programming for non-Programmers	- understand key computational ideas and structures - become familiar with basic Python programming code - write code to process data and solve	- university students non majoring in Computer science - post-Grads. - researchers	- five weeks - 15 hrs/week - one collaborative session/week - assessment = quizzes and code writing tasks

	common scientific problems		
Computational thinking	- understand algorithms - develop computational thinking skills - apply computational thinking in problem solving	- pre / in-service teachers - participants in a master's program	- four weeks - one day/week - two weeks theory, two weeks practice - assessment based participation in discussions, quizzes and cumulative portfolio
Collaborative Learning and Gamification with ICT	- engage learners in discussions - evaluate ICT tools - build networks of teachers - reflect on ICT in the classroom	- pre / in-service teachers - international students	- four weeks - 3 hrs/week - Assessment = quizzes and participation

In the following, the three MOOCs will be presented in regard to their respective course goals, participants, and expectations in greater detail. Moreover, the single MOOCs will be presented with a graphical design language that will be explained first.

5.4 A Graphical Language to Design MOOCs

Several approaches have been made to formalize learning environments, most prominently leading to establishing the IMS/LD standard (Koper & Manderveld, 2004; Koper & Olivier, 2004). The goals of these approaches were to allow teachers to describe and share their instructional designs. Moreover, the languages were designed to arrive at a level of formalization that made them machine-readable, allowing for a direct, ultimately automatic translation of the design into a TEL environment. One of the central challenges here is to keep the richness of the respective pedagogical ideas on the one hand, and making the design non-ambiguous on the other hand, in order for software developers to realize the design technically. To address this challenge, further attempts soon left behind descriptions based only on text and instead use specific concepts and relations comparable to programming languages. Especially for complex collaborative learning scenarios, there was a need to develop graphical languages that are both, understandable and non-ambiguous (Kobbe, Weinberger, Dillenbourg, Harrer, Hämäläinen, & Fischer, 2007; Weinberger et al., 2007). Further attempts designed for equally complex learning environments, such as inquiry learning, have further specified a large set of activities that define learning (de Jong et al., 2010; 2012).

A recent attempt has specified different social levels – relating back to Fischer and Dillenbourg's 2006 definition– on which orchestration is defined by learning objects and activities that can be allocated and specified on a small grain size (Dillenbourg, 2015). Building on this last attempt by distinguishing different actors, namely facilitator, individual learners, small group of learners, and class/community, any activity can be depicted with arrows that revolve around and produce learning objects (LOs) and tools. The location of the arrows' stems indicates the agent engaging in the activity, and the arrowheads point to the LOs or to the emerging learning objects (ELOs), which the activities lead to. Damaševičius & Štuikys (2008) describe LOs as digital resources that facilitate learning, while specific LOs can be derived from generic ones. A learning object can generally be defined a stable element that learners can reference and receive information from, for example a vocabulary list with definitions distributed to the learners. An emerging learning object in contrast is adapted and changed within the learning process. An example of an ELO may be a learner generated word wall that grows and changes over the course of a lesson or unit. The language builds on the idea of learning objects that are not given in advance and managed by the learning management system, but rather emerge in the learning process and are created by the learners (de Jong et al., 2010; Lejeune et al., 2009). Beyond topical coherence or technical features, which is indicated with simple connecting lines in the model, these ELOs are the principal link between learning arrangements in the above model, allowing peers to build on, modify, and discuss for knowledge construction.

Since the goal was to create a tool, which could be used in co-design sessions including teachers and educational designers, one primary feature of the graphical language was its simplicity (see Figure 1). Therefore each CoDe-Graph focuses on a single learning unit that can be replicated or adapted and combined with other units to create a course. In addition to the generic learning objects (LOs) and ELOs, one specific component – feedback – has been added which can emerge in the learning process, but is also a typical feature of assessments. Additionally, feedback can be created by teachers and peers alike. As the examples below will show, various elements of a learning environment may serve as feedback during the learning process.

Figure 1. Canvas and components of a simple graphical language to visualize orchestrated TEL environments (see Weinberger & Kolling, in press).

Typically, the co-design team, consisting of teachers, educational technologists, instructional designers, and other stakeholders, would begin by defining the learning goals and requirements. Learning goals may relate to specific sets of knowledge and skills as well as to meta goals such as self-development and membership in a community. Requirements may encompass learner prerequisites such as digital literacy as well as technological equipment and support needed to realize TEL. Next, the designers would establish which LOs are to be placed within the learning environment as well as specifying who created them, at which level they will be used, and how the learners are to interact with them. In most cases, the teacher or facilitator provides learning material as a LO to the individual learner who is expected to review the material. Learners may then engage in explicit learning tasks, using specific tools that result in artefacts or ELOs and that are in turn subjected to some kind of review process resulting in feedback. The items are arranged in the sequence that the learners will encounter them, and relationships between objects are specified as well as any versioning of ELOs that may occur. Finally, the described learning unit is put into context of other learning units. Iterations and modifications of the learning unit in future scenarios are defined. Moreover, the relation of the learning environment to other learning environments and its role in the educational trajectory of learners is clarified.

5.4.1 Course Goals

This course focuses on helping non-programmers (that is, students who do not major in Computer Science and/or Programming focused studies) to: a) understand important key ideas of computational representation and thinking, and b) develop introductory level Python-based programming skills to represent and solve common scientific problems.

By the end of the course participants should be able to:

1. Understand the key concepts of algorithm building such as: variable, control/decision structure, iteration/loop structure, properties and methods of data structures (list, directory, indexing, assignment, slicing), modularity principles, functions operations and file handling, and
2. Write Python code to read input date from a file, write appropriate algorithm to implement a scientific solution to a data processing problem, and storage output data back to another file.

5.5 The learners need not have any Programming for non-Programmers

programming background as this colMOOC course will introduce them gently into the programming domain by providing also example applications across various scientific disciplines demonstrating both numeric and text data processing. Finally, the course will guide participants to approach the Python programming language as a domain-independent computational thinking operationalization tool that adds value to their scientific skills and future professional profile.

5.5.1 Course Participants

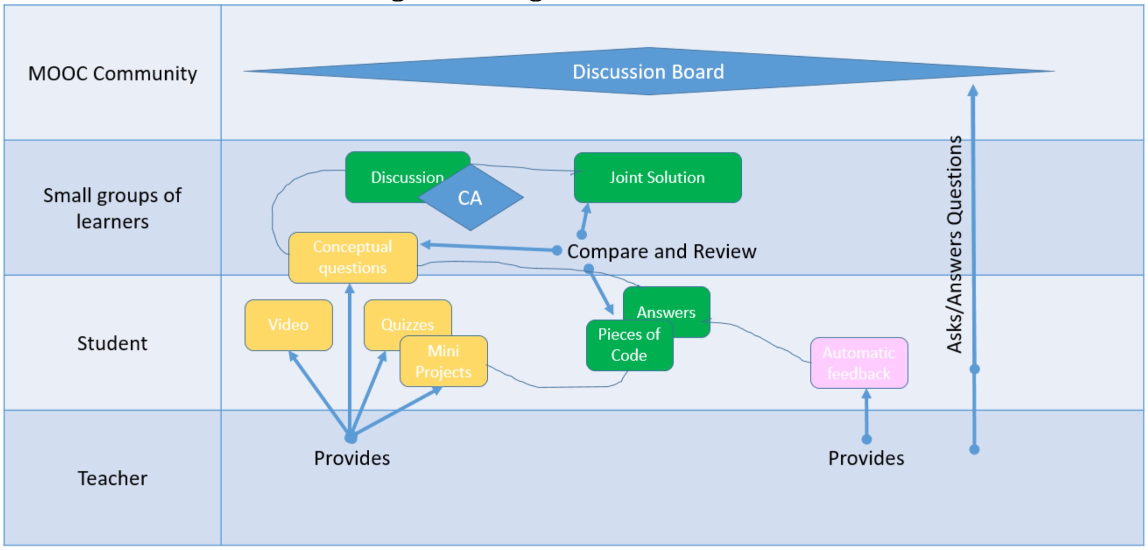
The course target audience is university students, postgraduates and researchers who do not major in Computer Science and/or Programming focused studies. Also, amateurs who would like to get introduced in Python programming could benefit from attending the course. Learners may choose this course because it is offered entirely online, or because it is offered as a vital supplement of their on campus work.

5.5.2 Course Expectations

Participants can expect to commit to spending approximately 10-12 hours a week for five weeks completing this course. There is a starting date and learners must complete each week’s session within that time frame. However, we will also explore the possibility of offering the course in a completely self-paced mode for all those interested. Learners are assessed by their responses to quizzes and the code they produce. Additionally, learners are expected to have one collaborative agent-based chat session per week.

5.5.3 Diagram of the course

Figure 2. Diagram of colMOOC c



Course "Programming for non-Programmers"

5.6 colMOOC Computational Thinking

5.6.1 Course Goals

This course focuses on problem solving with computational thinking approaches. Participants will gain a basic understanding of algorithms and computational thinking techniques and will be able to apply these techniques to problem solving scenarios. This course will also contribute to the participants' general knowledge and education on educational technology and distance learning.

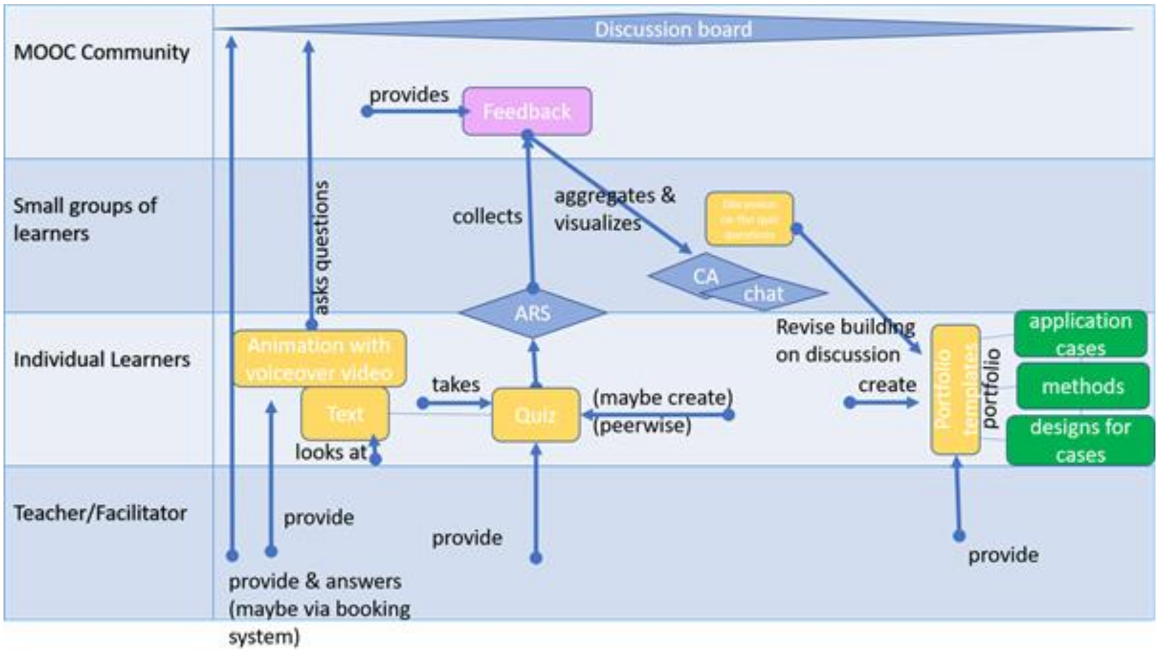
5.6.2 Course Participants

The course has three target audiences. First, many of the participants are expected to be pre- and in-service teachers interested in seminars or life-long learning programs that could help them apply computational thinking approaches in their classes. Second, enrolled students in Master's programs around education or educational technologies are also expected to be interested in the course. The MOOC design will therefore meet program requirements and will be aligned to already established programs available in Denmark. Finally, the majority of participants are expected to be independent learners interested in computational thinking. Despite the different backgrounds and personal learning goals we expect that all participants are going to be motivated, for different reasons (e.g., course requirement, own interest), to engage in course activities and argumentative debates. One issues that will be address in the course design is flexibility, since many participants will have time restrictions due to work (e.g., in-service teachers), studies (e.g., Master's students), or other (e.g., family responsibilities).

5.6.3 Course Expectations

The course will take place over four weeks and participants are expected to spend the equivalent of two working days each week on the MOOC, for a total of 50 hours. The first two weeks will focus on theoretical concepts and techniques and the last two on applying the concepts on real-life (or plausible) settings. At the end of each week, participants will meet a milestone. In order to receive a passing grade, participants will have to take part in the weekly activities (i.e., discussions, weekly quizzes, short assignments) and receive a passing score on their portfolio.

5.6.4 Diagram of course



3Figure 4. Diagram of colMOOC course Computational Thinking

5.7 colMOOC Collaboration and Gamification

5.7.1 Course Goals

Participants will learn about collaborative learning with ICT and gamification within the Teachers' Digital Competence framework. They will be able to engage learners in discussion and evaluate ICT tools for gamification and collaboration purposes. Additionally, the course will help to establish networks of teachers and give educators the chance to reflect on the challenges and benefits of introducing ICT into the classroom.

5.7.2 Course Participants

The target audience is formed by in-service teachers, as well as local and international students studying to be teachers. In the case of the students, the course will be offered as a complement to the degrees being part of an "internationalization" extension, and therefore these type of learners are expected to be strongly motivated. Some participants speak Spanish and others English, and thus material is provided in both languages. The course is entirely online and participants can access it from anywhere, however synchronous sessions are required and this may be a challenge for some participants to schedule.

5.7.3 Course Expectations

The course lasts four weeks and participants can expect to commit to spending three hours a week on the course. Each module is scheduled to last one week and ends with a formal assessment. While some deadlines are flexible others are strict in order to enable synchronous activities. T Participants will be assessed by their participation in discussions, and their self-assessment quizzes (minimum of 50% correct).

5.7.4 Diagram of the course

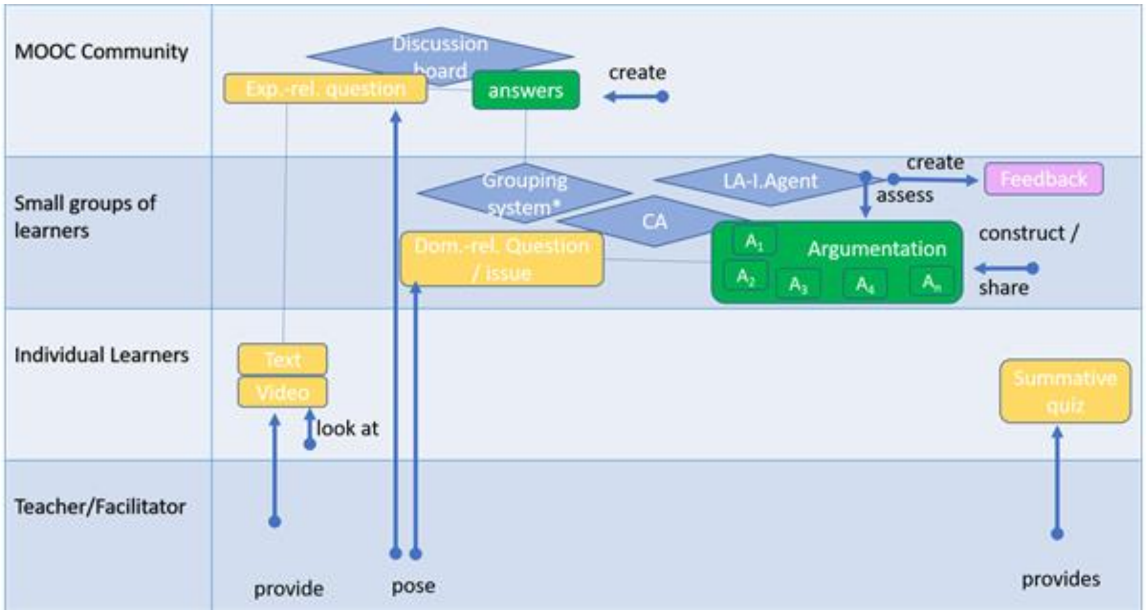


Figure 5. Diagram of colMOOC course Collaboration and Gamification

5.8 colMOOC Orchestration and Scripting in the classroom

5.8.1 Course Goals

Participants will learn about orchestrating classroom learning and using scripts with the support of with ICT. They will be able to discuss the theories that support orchestration and scripting and evaluate ICT tools commonly used for these purposes. Additionally,teachers will have the chance to discuss case studies together and work towards solutions for authentic problems with ICT in the classroom.

5.8.2 Course Participants

The target audience is formed by in-service teachers, as well as local and international students studying to be teachers or studying Educational Technology. In the case of the students, the course will be offered as a complement to the degrees and will receive two credit points for their participation. Participants speak German and all materials will be provided in German. The course is entirely online and participants can access it from anywhere, however synchronous sessions are required and this may be a challenge for some participants to schedule.

5.8.3 Course Expectations

The course lasts five weeks and participants can expect to commit to spending three hours a week on the course. Each module is scheduled to last one week. There are three discussion sessions and a self-assessment at the end of each module. A final assessment consisting of both open and closed questions will complete the course. While some deadlines are flexible others are strict in order to enable synchronous activities. The participants will be assessed by their participation in discussions, and their self-assessment quizzes (minimum of 50% correct).

5.8.4 Diagram of the course

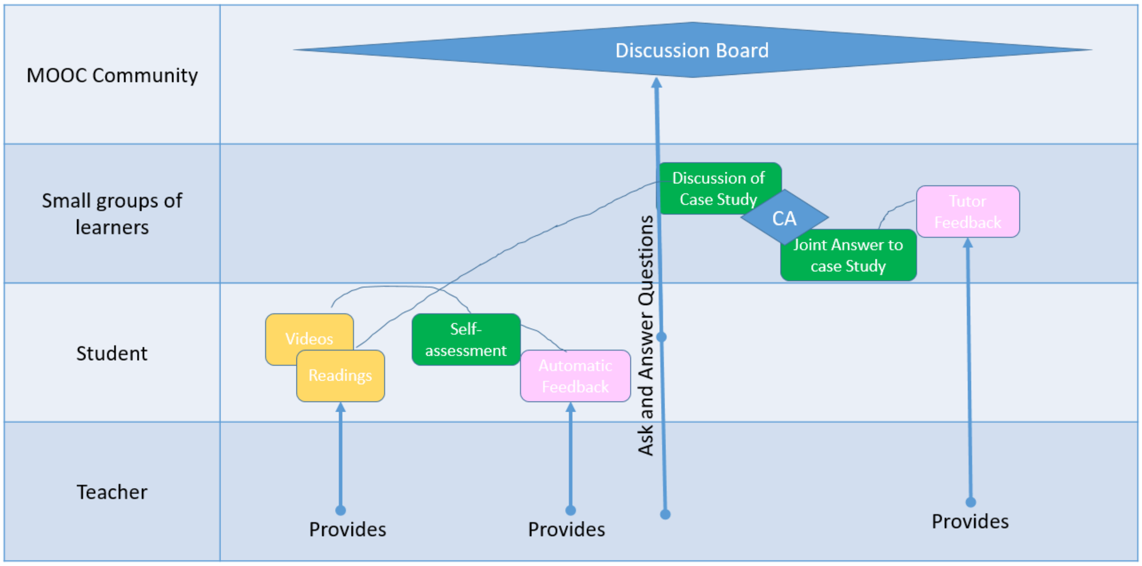


Figure 5. Diagram of colMOOC Course Orchestration and Scripting in the Classroom

6 Task Design and Creation

6.1 Task design within the colMOOC project:

One of the most critical elements of the colMOOC agent is its ability to adapt to the context and demands of highly varied individual -tasks. While the agent is does not work optimally with all types of learning tasks it can be implemented with a wide variety of tasks. This section aims to examine different elements of task design, which may affect the use of the CA.

Within the realm of CSCL there are several forms of joint learning many of which can be placed on a spectrum of cooperative to collaborative learning, or classified as peer tutoring. According to Weinberger et al. 2018, tasks are often classified on the basis of the division of labor (Dillenbourg 1999) but can also be classified based on other structural characteristics. Taxonomies distinguishing between task types are not unusual within social psychology (Steiner, 1972) cognitive psychology (Bloom, Engelhart, Frust, Hill & Krathwohl, 1956) , or in general didactics (Mager, 1965). We do not aim to create a full taxonomy of task characteristics or types, however we intend to highlight structural elements that are particularly well-suited for use within the colMOOC project.

Due to the inherent flexibility of the agent and task editor users of the colMOOC platform have a wide-range of options when designing their tasks. Among the most prominent is the decision of where to place the task on a spectrum of cooperative to collaborative, how open to make the task, and whether to focus the task on critical reflection, or implementing a process. Of course, some of these aspects overlap and each task is also impacted by the course content and the course expectations.

6.2 Cooperative V. Collaborative tasks

Cooperative tasks focus on each member of the group reaching a learning goal that they cannot achieve individually. At the heart of cooperative learning is shared dependency (Johnson & Johnson 2009). This usually takes the form of task division and knowledge exchange. This shared dependency can be naturally occurring, for example in interdisciplinary groups. In 2007 Meier, Rummel and Spada analyzed groups of psychology and medical students charged with making diagnostics in complex patient cases. The learners interpreted the information given differently depending on their discipline and then coordinated their approach with the others. Critical to their success was not only the ability to share domain knowledge, but also their ability to coordinate subtasks, time and technique. In groups where shared dependency is not inherently present, it can be generated within the task. This may require giving learners different background information, or intentionally and explicitly dividing the task into separate sections. The Jigsaw puzzle activity is a classic example of this. Each learner becomes an expert in one specific area, but the knowledge of multiple experts is ultimately needed to solve the full task (Aronson, 1978; Renkl, 2007). In many cases, it is possible to trace the contributions of individuals within the group.

Collaborative learning, in contrast focuses, on the transactive interaction of learners, with the criterion of transactivity moving on a continuum, since learners can relate more to each other in some situations, and less to each other in others. The characteristic transactivity has been found in several studies to be a central success criterion of CSCL scenarios (Teasley, 1997; Weinberger, Ertl, Fischer, & Mandl, 2005). Collaborative learning is therefore a form of collaborative learning in which it is difficult to share tasks, roles and resources. In addition, this results in a product that cannot necessarily be traced back to individual partial performance or objectives (WEINBERGER XXX).

6.3 Openness of the Task

The "openness of the task" refers to the extent to which individuals can independently determine how they approach and solve the task (Maier et al.; Leuders, 2015). The openness of a task can further be defined by the extent to which the context, the solution, and the goal of a task are given (Newell and Simon, 1972). In 2010 Maier et al. separated defined and undefined-tasks on this basis.

For defined tasks the initial condition and context are clear. This means that the question or problem contained in the task is given to the learners. In contrast, undefined tasks are those in which the question is rather open to interpretation, so that the problem must first be defined by the learner during task processing. In addition, Maier et al. (2010) further distinguishes between convergent and divergent tasks. While there is only one specific solution permitted for convergent tasks, there are several possible solutions for divergent tasks. This results in three logical task types that largely define the social forms of joint learning: defined-convergent, defined-divergent and undefined-divergent tasks. For defined -convergent tasks, there is a clear question or objective as well as a "correct" solution. For defined-divergent tasks, the task is clear but there are several possible solutions. An undefined-convergent task is essentially an oxymoron that would be not be possible to produce, but an undefined-divergent task would represent a maximum of openness, not only are there multiple possible answers, but it is possible to interpret the question and methods in several ways. Accordingly, typical examples of undefined-divergent tasks such as those used in collaborative CSCL scenarios characterize the discussion of controversial topics (Weinberger et al. 2018).

6.4 Task Orientation

Within the early stages of the colMOOC project it has become clear that it is also necessary to distinguish between the goals of the various task types. In the early stages two main goals became apparent, critical reflection and implementing a process.

In these tasks learners are often presented with a case study or scenario and an abstract problem to address. They must critically reflect on how to apply their theoretical knowledge to the praxis-based problem to reach a solution. While there are many possible answers, they should be grounded in the prior knowledge that learners have, either from their experiences of the class material. There are often several parts of the problem that need to be addressed creating an almost endless range of possible solutions.

A variation of this task would present a solution to the problem and ask learners to evaluate it for strengths and weaknesses as well as missing information. This has the advantage of reducing the possible responses, making it easier to map for the agent, but does restrict the discussion and may reduce independent thinking. In either case the agent can guide the discussion by following the theoretical information that learners can and should mention with relation to the individual aspects of the practice case.

6.5 Process Implementation

For domains where "correct" answers are not only common but essential the agent can also guide discussion by leading learners through the steps and help them avoid potential misunderstandings. Here two learners may approach a clearly defined problem and follow pre-established procedures, but can explain their actions to one another, work together to avoid common mistakes and support each other in implementing the skills needed to solve the task. Here learners are often asked to make their thinking visual so that the partners can learn from each other.

In the following section we will present two examples of tasks designed for early testing of the agent.

6.6 Example tasks

6.6.1 Scripting in Classrooms- Collaborative Discussion task

- Your colleague Mr. Lehmann reports on a new approach, which he has been trying out with his pupils in discussions. Instead of an open discussion, each **pupil receives individual instructions as to which "role" he should play in the discussion**, e.g. one pupil should be particularly critical in order to discover weak points in the argumentation, while another should structure the learning outcomes. The pupils, however, are getting more and more bored with this, which surprises Mr. Lehmann, because **the pupils liked the method at the beginning very much, and have only developed an aversion over time, although he would always change the roles**.

- Ms. Vogel, on the other hand, does not consider the method to be new at all, and finds it far **too restrictive for the pupils**. She thinks that **no natural roles can be formed**, which of course will bore the learners over time. In addition, **the pupils will never learn how to have successful discussions without a script**.

- Now you think that you can contribute information to this problem that you recently read in a scientific article... What are the advantages and disadvantages of Mr. Lehmann's approach? Could Ms. Vogel be right?

This task is an undefined-divergent collaborative task, which is focused on critical reflection. The task can be approached in several ways. Learners can choose which aspects to focus on and which to give lower priority to. There is no single correct answer, but rather a range of possible answers that can be theoretically supported by the materials the learners have seen in the lecture series. Finally, while each learner could answer the question entirely on their own, it is not a task that can be easily divided among multiple learners. Learners must reach a shared understanding based on the experiences and knowledge of both partners.

6.6.2 Algorithms

The table below shows the population of the 10 largest urban areas in Denmark. The table is sorted from the most populous to the least populous (Jan 2018, www.statbank.dk).

1. Write down the population of your hometown (both of you) and, using linear search, calculate how many comparisons you would have to perform to find out where your home town would be in the list (write the comparisons down).
2. Repeat the task, but use binary search this time. Which search algorithm performed better?
3. Now, imagine that, instead of the 10 largest urban areas in Denmark, the table included the population of all European capitals. Which of the two search algorithms would you have chosen to find the place that your home town would have in the list? Why?

Hint: to find out that your hometown should take, for example, the 3rd place in the list, you need to make sure that it is more populous than Odense and less populous than Aarhus.

This is a defined- convergent task that could be solved collaboratively or cooperatively and is focused on the implementation of a process. The task can only be interpreted in a single way and there is only one correct answer. Learners could, theoretically, divide the task each completing one single section and providing the information to the others, however, the task could also be solved collaboratively. One learner could end-up tutoring the other if there is a large difference in ability levels, or they could share the load and compare work and solutions in more homogenous groups.

Certainly there are numerous other task types that can and will be used within the colMOOC project. These are being gathered in a repository of task models that can be used as a reference during the pilot MOOCs.

7 Conclusion

This deliverable aims to provide information about the instructional design decisions that inform the colMOOC project. It begins by briefly reviewing the information presented in deliverable 1.1 and 1.2, but with a strong focus on the colMOOC context, in particular the trends that are currently being implemented in MOOCs and with Conversational agents. Then the deliverable aims to create course frameworks and descriptions that encourage collaborative learning in online environments. These descriptions, both written and visual, provide the basis for the next step of curriculum and course planning. This step is essential before producing content and making technical decisions as the pedagogical decisions featured in this deliverable are informed by the projects educational goals and motivations. The technical implementation of the aspects explored here will be addressed in future deliverables as solutions are found to meet the challenges of creating a collaborative environment, which features a conversational agent. This deliverable is the foundation for the future development of the courses themselves.

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