Reference:

Paper:
Designframework for an Adaptive, Hybrid MOOC: Personalized Curriculum in Teacher Professional Development

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Abstract:
The research project has developed a design framework for an adaptive hybrid MOOC that complements the MOOC format with blended learning. The design framework consists of a design model and a series of pedagogical design principles that can be used to design courses for teacher professional development. The project is methodologically inspired by Design Based Research.

Key words: Adaptive learning, Personalized Curriculum, MOOC, Blended Learning, Design Based Research.

1. Introduction
In 2020 it will be a requirement that Danish primary school teachers have a bachelor degree in the subjects they teach in. More than 10,000 teachers, who for many years have taught a course without being formally qualified, need professional development and therefore municipalities ask for new training concepts. There is a need for educational concepts that are flexible in relation to teachers’ work situations, are based on the fact that the teachers already have a number of professional skills, and at the same time are resource-efficient compared to the price and the time teachers must use to be formally qualified. Finally, the concept has to be scalable because it is uncertain how many teachers need training within each subject area. A number of municipalities (the customers) and University College Zealand (UCSJ: the provider) are in the process of examining whether the new training format "MOOC" (Massive Open Online Course) can solve this training task.

As part of this process UCSJ has established a research project with the aim of developing a design framework which can guide the development of instructional designs, adapted to experienced teachers’ different learning needs and study the factors affecting the actual realization, legitimacy and efficacy of the design.

2. Methods
The project is methodologically inspired by Design Based Research (DBR) (Brown, 1992; Collins, 1992) – a method widely used in MOOC research (Gasevic et al, 2014). The design framework has been developed through iterative design experiments (diSessa & Cobb, 2004). Several prototypes have been evaluated and redesigned and research has generated theory that can guide the further development process. We have analyzed interviews with participants and teachers and made observations of the participants’ interactions with each other and with the technology (Moodle). Through these design experiments it has been possible to develop a design framework consisting of a set of pedagogical design principles that can be communicated through one or more design examples (Hrastinski et al, 2010).
3. Prior research

Research in MOOCs has until 2012 been scarce (Kennedy, 2014; Liyanagunawardena et al, 2013), which is of no surprise since MOOCs were first offered in 2007/2008. MOOCs are based on previous research in e-learning (King, 2014) and experience from OER, where MOOCs differ by integrating open educational resources in an instructional design with an embedded but mediated teacher presence and clear learning objectives (Liyanagunawardena et al, 2013). The research has been oriented towards only a few topics including MOOC typologies with the dichotomy: C-MOOCs to X-MOOCs and the discussion of connectivism to behavioral and cognitive learning theory (Rodriguez, 2012; Liyanagunawardena et al, 2013). However this discussion is not so dominant anymore (Bayne & Ross, 2014), and several MOOC providers are developing MOOCs that integrate several different pedagogical approaches depending on the objectives of the learning e.g. inspired by Laurillard's pedagogical framework (Laurillard, 2012; King et al, 2014).

Participant perspectives and especially the high dropout rates among students still have had great attention (Rodriguez, 2012; Kennedy, 2014; Vivian, 2014). Hypotheses about how to reduce the dropout rate based on research show that learning is supported if the participants can interact with each other and with the teacher. Social presence and teaching presence, therefore, are important in an educational design (Kop et al, 2011) – forms of presence which particularly have been explored in the context of the COI framework (Garrison & Anderson, 2011). MOOC research has been primarily oriented towards developing social interaction between participants, for example, through peer to peer response methods. However, this has not solved the problem concerning dropouts (Gasevic et al, 2014). In formal education, where high dropout rates are unacceptable, there has been an increasing interest in educational designs that blend MOOCs with either on-campus teaching or synchronous online teaching and learning environments (Bayne & Ross, 2014; Gasevic et al, 2014).

The typical MOOC student is an adult who already has a degree and is fully or partly in job. The participation in a MOOC is for professional development either out of personal intellectual curiosity or in connection with the acquisition of specialized skills related to work (Vivian, 2014; Kellogg 2014; King et al, 2014). MOOCs can be an effective design for acquiring work specialized skills if the design is competency-based and enables personalized learning that matches the professional's need for additional skills (Norton et al, 2013; Milligan & Littlejohn 2014; Gasevic et al, 2014). This requires an educational design that can identify an individual's skills, identify skill needs and adaptively design a study for each student (Kostolanyova & Sarmanova, 2014). Personalized learning and adaptive education is a growing field of research (Kinshuk, 2015), also within the field of MOOCs where research, however, has been limited (Gasevic et al, 2014). The concepts of "personalized learning" and "adaptive education" are not clear concepts. "Personalized learning" is used not only to characterize competence-oriented learning but also in connection with theories about particular learning styles (Akbulut & Cardak, 2012). "Adaptive education" also covers several areas, including adaptive technical systems and adaptive instructional designs, better known as differentiated instruction. In the latter case, curriculum, learning resources, teaching and guidance are tailored to the learner's needs.

4. Design Framework for adaptive learning design - initial considerations

Adaption is feedback from an educational system adapted to the needs of learners (Bateson, 1998; Hattie, 2011). We distinguish between different forms of feedback (U.S. Department of Education, 2010):

**Differentiation** is education, where participants have the same learning goals, but the teaching method varies so they adapt to the individual student's needs.

**Individualization** is teaching, where the participants also have the same learning goals, but participants can move forward at different speed and relate to a particular content area or a given activity in different ways, and teaching is tailored to individual needs.

**Personalization** is education, where participants have different learning objectives, depending on their learning needs. The training is customized, so this is possible, and personalized instruction may also provide opportunities for differentiation and individualization.
In a research field, which grew from an influential study on adaptation by Lee J. Cronbach (Cronbach, 1957), it has been documented by many educational researchers that adaptive learning designs which adapt teaching to the individual learner’s needs, have an positive effect on the learning outcome (Akbulut & Cardak, 2012).

Attempts to individualize instruction with a technical system is however an older idea. Frederick Taylor (1911) was interested in the idea of a “teaching machine”. In 1958 B.F. Skinner introduced the idea of technology mediated programmed learning (Skinner, 1958), and in the 70s a lot of research in the field of Computer-Assisted Instruction (CAI) took place. The criticism of this approach and especially the radical behaviorism that Skinner developed has been intense in education research for decades.

Adaptive learning systems are this century's attempt to develop an educational technology adapted to users’ needs, and Simens et al (2015) refers to this technology as “fifth-generation” educational technologies. You can get important knowledge from design and development of these systems, even if you follow the basic criticism of the learning theories which some of these systems are based on.

4.1 Adaptive learning systems

There is a variety of different definitions of adaptive learning systems. The differences are mainly related to the level of adaptation, one imagines a system must be able to perform in relation to a participant and the learning process.

Most adaptive learning systems consist of three components (Natriello, 2011; Oxman & Wong, 2014):

a) A content model.

b) A learner model.

c) An instructional design model which is a strategy for the adaptation process.

4.2 Content model

The content model structures the content of learning objectives, sequences and tasks to be solved (Natriello, 2011). A content model divides the subject into smaller elements, which can be associated with different types of learning resources (Thalmann, 2014).

4.3 Learner model

An adaptive learning system also contains a model of the learner (Wenger, 1987). The model is based on one or both of the following categories: a) the learner’s current knowledge, and b) the learner's learning preferences.

It is widely agreed that it has a learning effect if the teaching is adapted to the individual’s knowledge. Pre-understanding or prior knowledge is considered as one of the individual factors that has the greatest importance in a learning process (Glaser, 1984). The model of the learner must visualize the personalized curriculum a given person should be offered in a concrete course. Most adaptive learning systems therefore identifies the learner's existing knowledge and compare the learner's knowledge with the knowledge structure or curriculum for a given subject.

The majority of all commercial adaptive learning systems also tries to model the learner's preference for certain types of learning processes. Attempts to categorize the learners in cognitive types or learning styles are here very common. In a review of 70 published articles on adaptive learning systems (Akbulut & Cardak, 2012) 81 % of the participating learning systems were using cognitive types or learning styles for modeling learners. Most used were cognitive types based on Kolb (1984) and learning styles based on Felder- Silman (1988) or Dunn and Dunn (1974). Despite the widespread use of models of the learner building on typologies of preferences in terms of learning styles or cognitive types, the same study showed that “findings on concrete learning outcomes were not strong enough” (Akbulut & Cardak, 2012 s. 835).

It is therefore important to be critical towards adaptive learning systems that emphasize the identification of specific preferences and hypotheses concerning specific learning styles. Especially because the development of a model of the learner on the basis of hypotheses related to the learner’s
preferences can develop into what is called "stereotype methods" (Shute & Zapata-Rivera, 2010).

Research shows that it requires training to be included in a MOOC design if the learner should have a positive learning outcome (Milligan & Griffin, 2015). Therefore models of the learner may also contain information about how the learner uses and relates to the learning design in a MOOC. Modeling of the learner therefore may include a classification of the learner on a scale from beginner to expert which a strategy for scaffolding can relate to (Milligan & Griffin, 2015).

The third dimension in an adaptive learning system is the strategy of adaptation. In terms of supporting the learner's navigation in the system the designers of the system use a variety of adaptation strategies. Basically, we can distinguish between two adaptation strategies: recommendation systems and guided navigation (Khribi et al., 2015). In a recommendation system the technology identifies a range of possibilities which the system priorities for the learner on the basis of a learner model or on the basis of the learner's performance in the system. But the learner is free to choose whether to follow the recommendation. By guided navigation the system hides the links which is not relevant to the learner, either because they do not match the model of the learner or because they do not match the learner's continuous performance in the system.

An important design discussion is the question of who should have control of the adaption process. Is it the system or the learner (Shute & Zapata-Rivera, 2010; Simens et al., 2015)? Review of research on adaptive learning systems shows that this is not always reflected in the design of the adaptive learning system (Akbulut & Cardak, 2012; Ford, 2013). The problem is that the adaption process may be invisible to the learner, since the rules or algorithms which are used to control the system is not known or understood by the user. The system can collect a large amount of data about the user (big data) through the monitoring of learners' interactions with the system (Siemens et al., 2015). This raises a number of ethical questions and dilemmas of privacy and users' control of their own data. Who owns the data, an adaptive learning system produces, and what can and should this data be used for?

5. Design criteria:

Based on knowledge about adaptive learning systems, we have defined a set of design criteria for the development of adaptive learning design in general:

- Modelling of the learner must be based on documented effects.
- Development of adaptive learning design must be based on a precautionary principle (ethical code) which means that we do not use stereotypical methods for modeling of the learner.
- Modeling should (only) visualize a) the learner's professional skills and b) experience and skills to learn in a MOOC format.
- Adaptation performed by a technical system based on non-transparent algorithms cannot stand alone.
- Adaptation must be a dialogue (negotiation) between the learner and a teacher on the basis of one or more technically-generated information.
- The adaptation strategy should be recommendations and the adaptation process must be transparent and controlled by the learner.
- The learner must control own data.

6. Findings

Based on the research review above, a series of design workshops and three iterative design experiments, we have developed a design framework for design of adaptive learning environments in formal education.
Figure 1. Design framework for an adaptive hybrid MOOC

The design framework visualizes three design levels:

6.1 Setting:
The design framework is based on a well-known design model which frames the design as a setting for formal training with a participant, a content and a teacher.

But we are following the widespread criticism of this model and situate the three elements of the model in the context they are part of (Garrison & Anderson, 2011).

- The learner is part of a personal learning network (PLN).
- The subject is part of a broader academic culture and its interpretation of the subject.
- The teacher is situated in an educational institution and more widely in an educational system.

The development of a specific adaptive learning design must be based on the framing and the concrete anchorage of the three elements in their specific contexts.

6.2 Relationships
The framework visualizes the characteristics of the relationship between the design elements described above:

a) The relationship between the learner and the subject is characterized by a personalized curriculum. Each participant has their own unique curriculum. The project has shown that participants with long working experience in a field have acquired a number of competencies related to the curriculum - skills that are very different from participant to participant.

b) The relationship between a participant and the teacher is characterized by complementarity. In traditional teaching concepts the relation between participant and a teacher is the core of the instructional design and teacher presence is the starting point for concrete designs for learning. However, this is not possible in an instructional design where all participants have their own personalized curriculum. In a group of participants who each have their own curriculum it is not possible to realize a multiple relationship: a participant - a content - a
The relationship between participant and teacher must be complementary if you want to support that all participants have a personalized curriculum.

c) Finally, the relationship between the teacher and the subject also has a characteristic feature that is far from usual perceptions about being a teacher. The traditional role of the teacher is the lecturer who interprets a subject and mediates the relationship between the learner and the subject in a face-to-face setting. The teacher identifies himself with the role of being a teacher. The project shows that the relationship between the teacher and the subject must be transformed from a teacher role to an author role. The teacher is rather a designer, an author and a producer of a number of learning resources. A role that also entails that the teacher is part of a larger production team.

6.3 Principles
Level 3 in the model visualizes the design principles. These principles relate to each of the three characteristics described above.

6.3.1 Personalized curriculum: Multiple learning path:
The design must be able to:

a) identify the participants current skills - visualized in a competency profile.
b) visualize a competence-gap in terms of a personalized curriculum.
c) recommend a learning path which adaptively matches the learner's personalized curriculum.
d) identify the student's ability to learn in and with a MOOC.
e) establish an adaptive scaffolding of the student's learning process in the MOOC.

The principle of multiple learning pathways, we will refer to as the design potential or affordance of the design.

6.3.2 Production of learning resources: The content model
In order to realize the principle of multiple pathways of learning, the educational institution in advance has to produce a content model of the course, that:

a) covers the entire curriculum of the subject.
b) includes a deconstruction of the subject to competency units.
c) guides the production of learning resources and forms of participation, which without progression are linked to each unit of competence.

This design principle can be described as a constraint for adaptive learning designs. The project demonstrates that particularly the breakdown of the subject to competencies which participants can study with no progression is a major challenge for the teacher/author that produces the concrete MOOCs.

The design framework includes no constraints regarding the choice of types of activity associated with specific stereotype, learning styles, etc. The framework thus encourages the development of a number of different types of activity associated with each competency including:

a) Passive activities: Participants are exposed to a learning resource.
b) Active activities: Participants need to do something related to a resource (solve a quiz, etc.).
c) Constructive activities: Participants must produce inputs to the system that contains ideas that are not found in an available system resource. (Ex. formulating solutions to a problem linked to their own practice).
d) Interactive activities: Participants are engaged in a dialogue with another participant, a teacher or the system on a given subject matter.

The above list is based on Natriello, 2011 and we will add:
e) **Collaborative activities:** Participants create together an output on the basis of the above activities with the possibility of including resources and tools that are not available in the learning design.

### 6.3.3 Complementary teacher presence: Representation of the teacher

The final design principle is a key constraint for the design of MOOCs in general and thus also for adaptive designs for learning on the basis of the MOOC format. Since the teacher cannot be present in a multiple number of learning pathways, the teacher must be represented in the design. The teacher must be mediated in a form that minimizes the disadvantage of a learning design where the teacher cannot be physically present. The concrete mediation of the teacher should, as far as possible, allow personalization of the teacher even though it is not possible to get immediate synchronous feedback from a present teacher. Therefore we are working on developing a design principle which we tentatively call asynchronous teacher telepresence. The project shows that it is extremely difficult for teachers to accept this constraint, and therefore educational institutions need to scaffold teachers who must perform the transformation from "teacher presence" to "asynchronous teacher telepresence". At the same time the project demonstrates that there are many ways to mediate the presence of the teacher including multiple video formats which are well known from MOOCs in general.

The principle of complementary teacher presence can be formulated as a scale, and an educational institution must in each case decide the extent to which it will complement the asynchronous teacher presence with synchronous presence forms either online or on campus. In this project UCSJ (the provider) has decided to supplement the design framework with blended learning activities on campus. Through a series of design experiments, the project has therefore developed principles which can complement the overall design framework.

#### MOOCs and blended learning

"Blended learning" is a floating signifier and definitions vary considerably. We use the following definition: "Blended learning courses integrate online with face-to-face instruction in a planned, pedagogically valuable manner, and do not just combine but trade-off face-to-face with online activity (or vice versa)" (Vignare, 2007 p.38).

Blended learning can improve the quality of education (Garrison and Vaughan, 2008), but as in all education, this depends on the quality of the instructional design. E.g. it does not increase the learning effect using blended learning in addition to a MOOC as a compromise to fix a poor online environment or to support the habits of the ‘teacher-dependent’ learner” (Milligan and Ringtved, 2015).

Research on design principles for combining MOOCs with face-to-face teaching is scarce. It is not possible to combine classroom instruction with the original MOOC concept which has a large number of participants spread throughout the world. Blended learning is possible only in concepts that are not massive, so-called “Little Open Online Course” (LOOC), Small Private Online Course (SPOC) (Chauhan, 2015), or in concepts combining a group of enrolled students on campus with global participants (Ronkowitz & Ronkowitz, 2015). In our project, we work primarily with small MOOCs similar to a SPOC.

The project shows that the **purpose**, the **extent** and the **relationship** between MOOC participation and face-to-face teaching is an important design issues. University College Zealand uses three different formats:

- MOOC-enhanced classes.
- Face-to-face enhanced MOOC participation.
- Exclusively MOOCs.

"MOOC- enhanced classes" are used in our regular bachelor degree programs. In this project, we use "face-to-face enhanced MOOC participation” in our adaptive professional teacher development.
MOOC participation is the essence of the participants’ learning processes and municipalities can then buy additional face-to-face instruction.

The design strategy in these courses is that face-to-face interactions must support the activities that have the greatest challenges in the online environment. The aim is to increase the learning outcome and reduce dropouts.

Our design experiments with blended learning have been inspired by the COI Framework (Garrison & Anderson, 2011). We have used the latest updated COI model (2015):

**The Community of Inquiry**

![Diagram of the Community of Inquiry](https://coi.athabascau.ca)

**Figure 2. The COI Framework, 2015.**

There are two major differences between this model and the learning environment we have developed in our adaptive MOOC. Firstly, the "teaching presence" in a MOOC is mediated (in asynchronous videos) according to the design principle referred to above. Secondly, the students’ "cognitive presence" is not about engagement "with content". Participants engage with different content according to their personalized curriculum. This means that interactions between teacher and participants on campus must be prioritized in a different way than in traditional blended learning concepts.

We have developed the following design principles for face-to-face interaction in a blended adaptive MOOC concept.

1. **It is not possible to teach common content - but the subject can be introduced.**

In our traditional blended learning concepts, classroom interactions are often given priority to content that depends on learning methods, which are not possible to implement online. E.g. learning processes that require sensory based perception. This is not possible in an adaptive design in which participants each have their own curriculum. But even if the participants already have a range of skills and extensive work experience in a profession, then subjects and disciplines develop over time and the project shows that all participants benefit from having introduced the newest paradigms.

2. **Use face-to-face interaction to support the asynchronous and mediated teacher presence in the MOOC.**

Through the introduction of the subject and the course in general, participants establish a trust to the teacher as an expert who can get them all the way through the course. This has a positive impact on the dropout rate.

3. **Provide adaptive response in terms of individualized and differentiated feedback on individual performance in the MOOC.**
Because the participants have different personalized curriculum, time on campus must be given priority to what is absent in a MOOC, professional feedback from the teacher. In doing so, the student model can be updated and the recommendation of an adaptation strategy which took place at the beginning of the course may be revised in dialogue with each student.

4. **Monitor student performance in the MOOC and elaborate in face-to-face teaching, content that is difficult for all students.**

We have good results when the participants and the teacher together select common content.

5. **Scaffold learning in and with a MOOC.**

The learning effect of participating in a MOOC is closely related to whether one has learned how to learn through this training format (Milligan and Griffin, 2015). Because most of our participants are MOOC beginners, we have to support them in learning in and with a MOOC. The project shows that it is easier to support this in face-to-face activities.

We also use face-to-face interaction in the same manner as in our other blended concepts. We support "goals and direction", we are "setting climate" and we support "discourse", i.e. students' interaction with each other and with the content. Particularly peer to peer activities in the MOOC require scaffolding.

7. **Further research**

In our ongoing evaluation of the relationship between design and learning outcomes we are inspired by Pawson & Tilley (1997). After testing the first prototypes we have data showing that the learning impact of the developed design will depend on the relationship between the design and the students' professional qualifications, motivation, conditions for participation and their ability to study in a MOOC. Three different municipalities have bought three different concepts based on the developed adaptive MOOC framework: 1) a concept that exclusively is a MOOC solution, 2) a concept that is face-to-face enhanced MOOC participation, 3) a concept that is close to being MOOC enhanced classes.

Further research will show which concept provides the highest learning outcomes and the lowest dropout compared to the concept's cost for the municipalities.

8. **References**


