Patterns for Using Top-level MOOCs in a Regular University

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Tags

Pedagogical Patterns, MOOCs and OER, Flipped Classroom

In this paper we describe pedagogical patterns for using MOOCs in a flipped classroom setting. These patterns are grounded on good practices in flipped classrooms.

In the course Mobile Application Development in our Bachelor computing programmes, students follow a MOOC of Stanford University. In this course, our students master key concepts and theories directed at building mobile apps, and follow the course in a flipped classroom setting. In our context, students watch videos of the MOOCs at home, make and submit exercises before classroom discussions, attend classes at school and present their mobile programming skills in a serious project.

In addition to passing the course goals, students find that they can successfully follow advanced top-class education. This supports them in developing lifelong learning skills. Furthermore, successfully completing an advanced Stanford course boosts their self-esteem.

The resulting patterns describe good practices for the design and use of MOOCs in a flipped classroom context.

1. Introduction

Massive Open Online Courses (MOOCs) have received much public, media and board attention since the first Stanford Artificial Intelligence course in 2011. The promise to deliver top-quality education has raised massive public interest. Many pupils, students and professionals have taken courses and quite a lot of them do exercises and assignments.

Most attention in the literature (Bayne & Ross, 2014; Knox, 2014) has focused on describing MOOCs, and most universities are interested in developing their own MOOCs. We are more interested in using MOOCs in our study programme, especially when these MOOCs originate from Stanford, MIT or other highly-respected universities. In this way, our students not only receive good education, but they can include in their résumés that they have successfully attended a Stanford advanced course in programming, for example, even though they studied at a regular university.

However, MOOCs are not designed for use in a classroom setting, but for students learning individually. Furthermore, it is not clear that the students from our university satisfy prior knowledge demands related to particular MOOCs of other institutes. Finally, we expect that most of our students will successfully complete courses. As the completion rate of MOOCs is rather low, this requires special attention.

Since 2010, we have used the flipped classroom in our Bachelor computing programmes (Diepen van, et al., 2015). We started with flipping the fourth year course "scripting for designers" and extended this pedagogical form to freshmen courses on programming (with an annual enrolment of 300 students). The flipped classroom addresses an ancient teachers' dream: prepared students in class. Our variant of flipped classrooms consists of:

- Videos explaining key concepts and how to use them. Students watch videos before a lecture.
- Exercises and assignments for the students related to the videos. Students submit their homework before a lecture. By submitting the homework, a student shows that she has given serious attention to the exercises. We do not require completeness nor correctness.
- Interactive lectures based on submitted homework. Feedback, connecting homework to key concepts, elaboration and preparing the class for the next videos.

By linking MOOCs to flipped classrooms, we managed to solve the MOOC classroom issues. The high workload involved could be reduced if MOOC designers would support classroom use by adding hooks to the videos that clearly describe prior knowledge requirements.

In this paper we propose three patterns: MOOC-BASED COURSE DESIGN, MOOC-HOOK and ACTIVE MOOC STUDENT. Table 1 gives an overview of these patterns including their target audiences. Within these high-level patterns, we might refer to other patterns using SMALL CAPS. These patterns are summarised in the Appendix. However, some of these referred patterns may not have been described yet - this is part of future work.

2. Background

Patterns as a way of describing design knowledge were introduced by Alexander, Ishikawa, & Silverstein (1977). Originating in architecture, patterns found their way into the domain of software development in the 1990s. Since then the pattern approach has been applied in various domains including Human-Computer Interaction, software processes, various arts and also education

Pedagogical patterns

Patterns for the latter domain, education, were first initiated and collected by the Pedagogical Patterns Project[1] , but many other authors also contributed to the body of pattern literature in this field (see e.g. Köppe, 2013; Mor, Mellar, Warburton, & Winters, 2014; Schmolitzky & Schümmer, 2009). These patterns – and pattern languages – covered various aspects of education and are mainly based on constructivism. The aspects range from general pedagogical principles (e.g. ACTIVE STUDENT or LINKING OLD TO NEW), to patterns for specific instructional methods (e.g. for lectures (Köppe & Schalken-Pinkster, 2013) or team projects (Hayeset al., 2006) to content-specific patterns, teaching software design patterns and the usage of technologies in education. But the emergence of new methods of instruction continue to form new sub-domains for educational patterns.

3. MOOCs

Pattern Name	Summary	Target Audience
MOOC-BASED COURSE DESIGN	Use a high-level MOOC as base for a course in order to save time and to guarantee high quality.	Lecturers at regular universities
MOOC-HOOK	Provide Hooks in your MOOC so that other educators can use these to link their own material.	MOOC designers
ACTIVE MOOC STUDENT	Ensure that participants of the MOOC are actively learning and not passively consuming.	University lecturers, MOOC designers

Table 1: proposed patterns

The huge interest in MOOCs started in late 2011 with the online Stanford introductory course in Artificial Intelligence. The understanding of MOOCs is rapidly growing. Two frequently cited contributions are Pappano (2012), a newspaper article, and a case study on an early MIT MOOC (Breslow, Pritchard, DeBoer, Stump, Ho & Seaton, 2013, vol 8). In Bayne & Ross (2014), an overview is given of UK MOOCs and their pedagogical base. Since 2013, various conferences like eMOOCs (Cress & Kloos, 2014) have been organised. In 2015, MOOCs have become part

1 www.pedagogicalpatterns.org

of major educational conferences like EADTU. But as far as we know, not much attention has been given to using a MOOC as part of an ordinary course.

Similar to MOOCs, flipped classrooms are the result of experiments by teachers. Instead of sharing lectures with students all over the world, the flipped classroom is directed at improving the learning processes of students in a class. The core idea is to shift lecturing to a students' class preparation, and to use class time itself for interaction with students. Lecturing can be recorded on video; the context in our work is to use excellent MOOCs (of the best experts) for lecturing and to support our students to understand and use these MOOCs in our own educational setting.

Educational Context at our University

The goals for using the flipped classroom in our computing courses are to increase student understanding and skills in programming. Based on Chickering's principles for good Bachelor education (Chickering & Gamson, 1987), Garrison's best practices for blended learning (Garrison & Vaughan, 2008), and Lean principles for waste reduction in processes (Balzer, 2010), we have designed each lesson in the courses by three elements: studying a knowledge clip (in our case a video explaining theory, concepts and its application), making exercises and submitting results, and classroom discussion between staff and students (Diepen van, et al., 2015). The role of MOOCs in this setting is to use the high quality educational material of others in the knowledge clips instead of producing the material ourselves.

Using a MOOC in a regular university course is quite a challenge. Appropriate MOOCs have to be found, studied and assessed on their usability (and copyright statements) for teaching in our preferred pedagogical set-up of a flipped classroom. In our case, this has led to the selection of a Stanford online course on Mobile Programming for IOS devices (published as an Open Education Resource under a Creative Commons License). This video should have been augmented (only permitted under some CC licenses) with exercises to stimulate active student learning. Not all of the challenges are addressed in the proposed patterns and remain part of future work.

Methodology

Our proposed patterns address several issues based on our experience in using a MOOC in our course. This way of finding patterns is different from the established way of analysing at least three known occurrences of working solutions in order to mine the essential pattern from them, which is pattern mining by pure induction (Kohls, 2013). Our patterns are partly mined by analysing the missing aspects of existing solutions (in our case, existing MOOCs), followed by an abductive inference of a working solution. This also means that we can't claim that these are really mature patterns, as they do not satisfy the often used Rule of Three (Biggerstaff & Richter, 1987): if the solution worked in three or more cases, then it's likely not a coincidence anymore but a pattern. Instead, we propose them as proto-patterns[2] or abducted pattern candidates, which still need proper validation through successful applications.

4. The Patterns

Pattern: MOOC-BASED COURSE DESIGN

Context: In the design phase of a new course, you have identified the content and are now looking for ways of how to present the content. You not only want to present the content, but also want students to feel that they are able to handle high-level material.

Problem: Preparing high-level material is very time-intensive, and even if you manage to prepare such material, the students might not experience it as such.

Forces: The "not invented here"-syndrome can lead to re-doing existing work. This may also happen when schools insist on creating institutional learning materials themselves. On the other hand, courses that are developed by the institutions themselves, but - because of lack of time or experience - are not completely developed when the course starts or are of low quality, can lead to unsatisfying experiences for both students and teachers.

Solution: **Use a MOOC provided by a prestigious institute or professor as the basis for your course and design all other instructional parts around it.**

Using such a MOOC in your course will have some positive effects: the students know (if they are familiar with the institute or professor) that the material is likely to be of high quality and cover the state of the art in the topic. If the MOOC covers all aspects relevant for the course, then integrating this MOOC will also save time for the design of the course (this is similar to using a textbook and other educational material for your

2 http://c2.com/cgi/wiki?ProtoPattern

course). However, if the MOOC does not address all aspects of the course content sufficiently (or covers too much), then the course preparation has to take this into account. If important topics are missing, then the course designer should be able to link additional relevant material to the MOOC using the provided MOOC-HOOKs. Such material could be either another MOOC, or readers, other short videos etc.

Applying this solution requires a sequence of steps: find a MOOC (or combination of MOOCs) that fits the learning objectives of your course; adjust course planning and MOOC structure; optionally create additional material on topics not covered by the MOOC; and add supplementary material such as exercises or quizzes, or use MOOC-HOOKs to connect with other information sources.

Related patterns: MOOC-BASED COURSE DESIGN is an alternative for TEXT BOOK COURSE DESIGN and can help with implementing a FLIPPED CLASSROOM

Example: A large part of the course Mobile Application Development at HAN University was developed around the Stanford Online Course "Developing iOS 7 Apps for iPhone and iPad"[3] . This material covers about two-thirds of the available course time. The rest was developed using a selection from the (Coursera) MOOC "Programming Mobile Applications for Android Handheld Systems"[4] by the University of Maryland.

Supplementary material was developed covering:

1. "viewing questions" that students could answer while watching the video (and submit using an online form). The viewing questions that came with the Coursera MOOC were (partly) replaced.
2. exercises that students could do to experience the subjects discussed in the MOOCs.
3. extra material (videos, online articles and exercises) to address gaps between the required knowledge and the actual knowledge of our students (for example, about the programming language C).

For testing in the iOS part of the course, the assignments from the Stanford material were used. These were graded using the Stanford requirements and some additional criteria. For testing in the Android part of the course, an assignment from a (now defunct) Harvard course on mobile programming was used with some extra subject matter.

3 http://https//itunes.apple.com/us/course/developing-ios-7-apps-for/id733644550

4 https://www.coursera.org/course/android

Pattern: MOOC-HOOK

Context: You are designing a MOOC which also should be usable as a basis for courses in your own university or other institutions.

Problem: If students are not able to follow the MOOC anymore because they have problems connecting their prior knowledge to the presented concepts, they will be likely to drop-out and therefore do not reach the desired learning objectives of the course.

Forces: There is often a diverse student population and it is sometimes not known who exactly will take the class and what their prior experience is. It is also hard to take into account all potential topics that need or should be covered in the MOOC if the broader curriculum is unknown. As a MOOC designer, you can't know what has already been covered in the curriculum of the university that is using the MOOC for their courses.

Solution: **Identify parts in the MOOC where certain prior knowledge is essential for understanding and provide a HOOK for linking additional material at the moment when it is needed by the students.**

Ideally, the users of the MOOC (the university lecturers who apply MOOC-BASED COURSE DESIGN) will easily be able to connect the other material to the MOOC-HOOKs through hyperlinking or a similar mechanism. In that case, these links will show up at relevant moments and the MOOC-participants can activate them for acquiring or refreshing the additional essential knowledge. However, not all video-learning environments that are used for MOOCs offer such functionality. In such a case, a more simple solution would be to provide a list with moments where certain prior knowledge is assumed so that the lecturer can add the links to the additional material to this list. In both cases, the HOOKs should be optional so that students can also choose to skip them if they don't need them.

Offering MOOC-HOOKs makes it possible to handle a diverse student population with mixed prior experiences, but identifying the appropriate parts in the MOOC and the related essential prior knowledge costs extra time.

Related Patterns: LINKING OLD TO NEW, DIGESTIBLE PACKETS, REPEAT YOURSELF (indirect application, what you can do as teacher (repeating important topics) can also be integrated in

MOOCs by HOOKs, so even though we are quite sure that the students have the required knowledge, it still might be a good idea to offer a HOOK to older/other material again), STUDENT DRIVEN LECTURE (a basic aspect of MOOCs: being able to choose for yourself what and when to learn next; HOOKs add that the students do not only choose between the content presented in the MOOC, but also of related content).

Examples: In our course Mobile Application Development we studied the Stanford MOOC on iOS programming to identify gaps between actual and required prior knowledge and added hooks to the original material ourselves. In many textbooks, it is common to describe prior knowledge requirements either in an overview or in an introduction of a book chapter. Transfering this text book practice to a MOOC results in the hooks.

In a MOOC on design patterns the UML notation is usually assumed as prior knowledge. However, if specific parts of the UML are applied for showing the structure of certain patterns, e.g. the interface notation and implements relation, then a MOOC-HOOK could be provided that links to a website where these parts of UML are described in detail.

Pattern: ACTIVE MOOC STUDENT

This pattern is a refinement of ACTIVE STUDENT (Bergin, 2012).

Context: You're using a MOOC for your course.

Problem: Just presenting the topic in the MOOC might not be sufficient to assist the students in understanding it. You simply don't know if students have learned anything during the MOOC/course and discovering this only at the end of the MOOC/course is most likely irreparable.

Forces: Listening, watching and reading can be passive activities that do not automatically lead to learning. But you have no direct influence on the MOOC itself to trigger students' more active engagement with the material.

Solution: **Add regular exercises and assignments to the video and use the students' solutions to get a grip on the their progress.**

Exercises and assignments promote active learning, and the students have to apply the newly acquired knowledge and hereby demonstrate their level of competence. Using the students' solutions amplifies the benefits of this pattern: making the submission of results obligatory (as pre-requisite for using them) likely encourages the students to not skip them and, by examining the solutions, you as teacher can identify misconceptions and also well-understood concepts and adjust the in-class meeting according to this information. However, the examination of the students' solutions certainly costs extra time and it might be hard to impossible to always examine all of them, depending on the class size. In that case, random samples might help to at least get an indication of the students' performance.

Make sure that the exercises/assignments are in sync with the presentations and other material. Also use the results of these exercises/assignments for providing feedback to the students on their own learning progress.

Related Patterns: USE STUDENT SOLUTIONS as basis for providing FEEDBACK.

Example: The exercises in the "Scripting for Designers" course.

5. Discussion

Our work on using MOOCs in a course is based on our experience on stimulating student learning in Flipped classroom design. As a regular university we would like to use MOOCs in our courses as a more activating component than the textbooks that we currently use and as a part of preparing students for lifelong learning. For MOOC designers this implies that they include MOOC-HOOKs in their videos identifying prior knowledge, or even better, offering quick lessons to fill the gap. Use of MOOCs in education at regular universities is still rather new and it will take a while before support as offered in textbooks is given.

Our research is focused on developing and understanding flipped classrooms in higher education. We hope that working with pedagogical patterns as a way to describe good practices in education helps with identifying and sharing our knowledge and that of others in a comprehensible and reusable way. One of the next steps in this research is the work on a pattern language for flipping the classroom in computer science education.

Appendix

SUMMARY OF REFERENCED PATTERNS

Pattern Name & Reference	Summary
DIGESTABLE PACKETS (Bergin, 2012)	Applying this can lead to smaller elements which are small because they don't cover certain aspects of the topic, which are assumed to be known a priori.
FEEDBACK (Bergin, 2012)	Give the students differentiated and objective feedback on their performance.
FLIPPED CLASSROOM (e-teaching.org, 2015)	Students are preparing themselves at home in advance of a lesson.
LINKING OLD TO NEW (Bergin, 2012)	Help the learner to make associations between new information and existing knowledge by using an old wrapper to introduce this new information.
REPEAT YOURSELF (Bergin, 2012)	Repeat important topics so that they are easier to remember and link to each other.
STUDENT DRIVEN LECTURE (Bergin, 2012)	Let students select topics that are covered in the lecture.
TEXT BOOK COURSE DESIGN (unpublished)	Selecting a text book as backbone in designing a course.
USE STUDENT SOLUTIONS (Köppe et al., 2015)	Use the work that students have handed in as examples in class.

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Edition and production

Name of the publication: eLearning Papers
ISSN: 1887-1542
Publisher: elearningeuropa.info
Edited by: P.A.U. Education, S.L.
Postal address: c/Muntaner 262, 3r, 08021 Barcelona (Spain)
Phone: +34 933 670 400
Email: editorialteam[at]openeducationeuropa[dot]eu
Internet: www.openeducationeuropa.eu/en/elearning_papers