A Tool to Support MOOC Teachers with Questionnaires, Adaptive Lessons, and Experimental Comparisons

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Abstract

One promise of online learning is the opportunity to swiftly experiment and implement. That is, the digital nature of online learning greatly eases the process of randomly assigning learners to educational interventions, selecting the most promising one, and propelling that intervention to all learners. Such evidence-based interventions enable iterative and domain-specific improvements to online learning environments. In Massively Open Online Courses (MOOCs), a popular branch of online learning, learners could benefit greatly from such improvements, provided that their teachers are equipped with the appropriate tools for the experiment and implement routine. In the current paper I introduce a software protocol that exploits Qualtrics, popular software for creating and distributing surveys, to extend native MOOC functionality with random assignment, additional educational elements, and options for personalizing educational content. The protocol is not only available to MOOC teachers, but can also be easily adapted to any online learning environment that supports the Learning Tools Interoperability (LTI) protocol. I discuss some of the major issues in MOOC research and show how the Qualtrics bridge can contribute to those issues, ultimately providing MOOC teachers with a powerful tool to make evidence-based course improvements.

A Tool to Support MOOC Teachers with Questionnaires, Adaptive Lessons, and Experimental Comparisons

Opinions vary on the desirability of the rise of Massive Open Online Courses (MOOCs) (e.g., Baggaley, 2013; Ng’ambi & Bozalek, 2015; Siemens, 2015). However, regardless of whether you are a proponent, opponent, or take a stance somewhere in the middle, in the forthcoming future MOOCs will most likely keep influencing the shape of

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higher education. In 2016, over 700 universities were involved with MOOCs, offering about 6850 courses, and enrolling an estimated 58 million students (Shah, 2016). These figures, and the steady rise of blended learning, do not seem to herald a decrease in their popularity. With such a massive reach and potential impact, ensuring the quality of these courses is indispensable (Gamage, Fernando, & Perera, 2016). At the same time, with so many different universities involved and such a rich variety of offered courses, ensuring that quality is far from trivial.

One important complicating factor in guaranteeing quality is the inflexibility, or lack of versatility, of virtual learning environments (VLEs) such as MOOCs. A decade ago, Severance, Hardin, and Whyte (2008) already stressed that "...monolithic VLEs are too hard to customize at the individual user level, and evolve far too slowly to meet teaching and learning of users who want their teaching and learning environments to be under their personal control." In an effort to increase the versatility of MOOCs, in this paper I introduce a software protocol that enables three extensions with major importance to both teachers and researchers: questionnaires, adaptive lessons, and experimental comparisons. In the following, I first discuss some issues involved with improving MOOCs, and finally how the protocol targets those issues.

Issues Obstructing the Improvement of MOOCs

To begin with, Reich (2015) identified various pressing issues that impede leveraging the quality of MOOCs. First, the assessment of learning gains has so far been quite limited, as accurate measures of learning are difficult to obtain, and popular pseudo-measures such as measures of engagement can be deceiving. In order to sensibly evaluate the quality of a MOOC, additional measures that may not be readily provided by the MOOC provider are thus required.

Second and third, a lack of data sharing hinders the comparisons of learning interventions across various domains and circumstances, and although general domain-independent interventions may surely improve the quality of MOOCs, more complex domain-specific interventions might be required to fully optimize those courses. Thus, improving the quality of MOOCs requires the teachers and researchers involved with a specific MOOC to adapt their teaching and research to the peculiarities of that domain.

In addition to these issues, Savi, van der Maas, and Maris (2015) stressed the need for prioritizing adaptivity in MOOCs. Rather than the current one-size-fits-all approach, a strong personalization of MOOCs is required to serve each student's individual needs.

Notwithstanding these issues, the most rudimentary one, that of a lack of versatility, is regularly ignored. Namely, although MOOC teachers and researchers must consider the aforementioned issues, MOOC environments not necessarily provide the required functionality to do so. Indeed, the design of effective learning interventions requires a significant flexibility in adapting a MOOC to the needs of the teacher or researcher involved. However, these needs, such as for instance the adaptive assignment of problems or instructions to students, may go beyond the existing functionality of the used platform.

Furthermore, in order to discern whether an intervention improves the desired learning outcomes, one must be able to randomly assign different variants of the MOOC to different students. This approach, better known as A/B testing (Savi, Williams, Maris, & van der Maas, n.d.), enables a double-blind, iterative and evidence-based optimization of

the MOOC in question. On the one hand, fortunately, the large scale of MOOCs particularly suits experimental comparisons. On the other hand, unfortunately this time, again the functionality may not be available, or may be too limited for ones needs. Such lack of versatility thus may severely obstruct the opportunities of teachers and researchers to optimally and decisively improve the quality of their course.

A Potential Approach

As this lack of versatility is the most rudimentary, in this paper I introduce and discuss one potential approach to tackling it. This approach is to use Learning Tools Interoperability (LTI) (Severance, Hanss, & Hardin, 2010), a specification for the standardized integration of learning tools, in combination with Qualtrics, which is widely used software for creating and distributing online surveys. In the following section I briefly discuss the LTI specification, Qualtrics' potential to extend MOOCs with questionnaires, adaptive lessons, and experimental comparisons, and the protocol that ultimately bridges MOOCs with Qualtrics.

The Qualtrics LTI Bridge

LTI

The LTI specification to begin with, enables a teacher or researcher to enhance his or her MOOC with student-access to additional external learning tools, while ensuring that small pieces of information (such as user id and grade) are exchanged between the MOOC and the external tool. The benefit of this approach is that it extends the native functionality of the MOOC platform with the functionality provided by the external tool, essentially creating a modular learning system.

Many VLEs support LTI, including the widely used Coursera and edX, and it is not uncommon to see the obtained modularity utilized. A common goal in many use cases is to increase the pedagogical range of a MOOC. Examples range from the addition of educational games (Fontenla, Perez, & Caeiro, 2011; Freire, del Blanco, & Fernandez-Manjon, 2014) and Intelligent Tutoring Systems (Aleven et al., 2016; Aleven et al., 2015), to MOOClets (Williams et al., 2014), modules from Carnegie Mellon University's Open Learning Initiative (Koedinger, Kim, Jia, McLaughlin, & Bier, 2015), asynchronous peer instruction (Bhatnagar, Lasry, Desmarais, & Charles, 2016), remote laboratories (Salzmann, Gillet, & Piguet, 2016), and project-based collaborative learning (Cheng, Yu, Park, & Zhu, 2017).

Importantly, the LTI approach provides a significant contribution to tackling the aforementioned issues. First, the external learning tool may establish access to additional measures of learning. Those measures can tap into a different granularity of the learning process, and thus enrich the estimation of learning gains and processes. Second, the additional flexibility of such a tool creates new opportunities for the implementation of more complex domain-specific interventions. This way, teachers and researchers are better served in deploying their (technological) pedagogical content knowledge (Mishra & Koehler, 2006) for the enhancement of their course. And third and fourth, the tool can offer opportunities to further personalize the learning experience, adapt it to the needs of individual learners,

and importantly, enable random assignment for experimental comparisons and thus aid in making evidence-based improvements to the course.

Qualtrics

Qualtrics in its turn redeems these promises to a large extent, making it a great candidate for the LTI integration. The software’s functionality includes the desired random assignment, and moreover offers an additional layer of flexibility in course design, including functionality that can be of great use in learning environments such as MOOCs. Here, I summarize a few of the most attractive features.

Qualtrics has an intuitive point-and-click and drag-and-drop interface, which enables new users to quickly master the software, yet gives plenty opportunities for adapting the survey to ones needs. Crucially, it supports the inclusion of typical educational elements, such as instructions, embedded videos, and quizzes. If necessary, it is even possible to include custom-built elements. For instance Barnhoorn, Haasnoot, Bocanegra, and van Steenberg (2014) created a tool for online reaction time experiments, which could be used to introduce students to behavioral research.

As the software is optimized for surveys, it offers a large flexibility in question design. It not only supports a rich variety of question types, such as rank order questions, constant sum questions, and timed questions, it moreover supports randomizing the order of both questions and answers. Also, the supported Likert scales and visual analogue scales can greatly benefit MOOC research that requires the use of questionnaires.

Interestingly, Qualtrics also supports carrying forward the answer of one question to a subsequent question, and it can present questions, instructions, or complete blocks of educational material conditional on for instance a previous answer or an external user id (such as the id used by the MOOC provider). These options enable a straightforward rudimentary form of adaptivity and can thus benefit personalization of the course material.

Finally and importantly, the software enables the random assignment of course components. This feature enables experimental comparisons and is key in providing an evidence-based method to iteratively optimize the course and increase its effectiveness. To further facilitate this, Qualtrics provides many opportunities for recording learner activity, creating an opportunity for additional measurements of learning gains and learning processes.

Qualtrics also has two major limitations. First, a clear restriction of Qualtrics is that it is proprietary software that requires a subscription fee. Although a free version is available, this does not offer the capacity required for the typical large number of learners in MOOCs. That said, being one of the more popular software packages for surveys, many universities already provide subscriptions to their staff.

Second, Qualtrics currently does not provide native LTI support. Although without such support MOOC teachers can still send students to the additional material in Qualtrics, it is not possible to match the responses from both environments. Such matching of responses often is a requirement for both teaching and research purposes. Teachers may want grades from Qualtrics quizzes to be returned to the MOOC environment, while researchers may want to combine information from both sources in their analyses. Therefore, in order to circumvent the lacking LTI support, an LTI bridge was developed.

Qualtrics LTI Bridge

In order to circumvent Qualtrics' lacking LTI support, the Qualtrics LTI bridge appends the URL that is used to send the student from the MOOC environment to Qualtrics with a query string containing the relevant information. Such passing of information is necessary for identifying the MOOC learner in the Qualtrics environment, and matching it to his or her responses on the additional course elements.

The software protocol that bridges the MOOC environment and Qualtrics is available on GitHub¹ (Poesse & Wiles, 2016). The protocol works with any MOOC platform or virtual learning environment that supports LTI. Importantly, the protocol includes detailed instructions for teachers and researchers on how to implement the protocol and adapt it to ones personal needs. The protocol is open-source, and thus free for everyone to use and build upon.

From the viewpoint of a learner, the LTI bridge integrates Qualtrics by creating an URL that directs the learner from the MOOC environment to the Qualtrics environment. The MOOC teacher naturally decides on the location and timing of the link. As the URL is appended with the user id that is used by the MOOC provider, the learner can be identified from within the Qualtrics environment. Once the learner enters the Qualtrics environment he or she can start studying the material that was created by the teacher or researcher. This can be a rich variety of materials, including the examples given in the previous section. In case of experimental comparisons, the user can be randomly assigned to one of multiple conditions. Once the learner has finished studying the educational material, the responses are recorded in Qualtrics and the learner can return to the MOOC environment. The response data can be easily exported by the teacher or researcher involved. And interestingly, Qualtrics allows for customization of the page design, such that the layout of the Qualtrics environment can be matched to that of the MOOC environment.

Finally, it is possible to grade assignments and quizzes in Qualtrics, and return the grades to the MOOC environment. This is important in case one wants the performance in Qualtrics to count towards the achievement in the MOOC. Importantly however, as the LTI workaround fails to take advantage of the full LTI specification, it does not support a fool-proof two-way interaction between the MOOC environment and Qualtrics. Although for instance Coursera accepts incoming grades, and Qualtrics provides automatic grading, the workaround cannot guarantee an accurate and secure transfer of those grades.

The instructions on GitHub are updated as soon as changes are made to the protocol. As the GitHub environment enables anyone to contribute to the protocol, researchers are encouraged to implement and test the protocol, contribute to the instructions, provide usage examples, or adapt the protocol. Feature requests or bugs can be filed directly at the protocol-repository on GitHub, or be sent to the author.

¹The protocol is available at https://github.com/renspoesse/qualtrics_lti_bridge. The protocol was adapted from an earlier bridge developed by Simon Wiles at Stanford University, which was generously shared at https://github.com/cognitivesciencelarning/qualtrics_lti_bridge. Instructions for using and adapting the protocol are available at https://github.com/renspoesse/qualtrics_lti_bridge/wiki, where you can also contribute to the instructions or provide usage examples. An issue or feature request can be filed at https://github.com/renspoesse/qualtrics_lti_bridge/issues.

Discussion

The Qualtrics LTI bridge extends the pedagogical range of MOOCs, and enables teacher-driven experimental comparisons on platforms that do not, or insufficiently, facilitate such comparisons. The added educational elements enrich and diversify not only the learning experience, benefiting the possibilities for creating more domain-specific learning interventions, but also the learning measurements, enabling a more fine-grained evaluation of learning gains and processes. In combination with experimental comparisons teachers can iteratively and decisively improve their course.

Moreover, the Qualtrics bridge is not confined to MOOCs. Since the LTI protocol ensures a connection between any two online learning environments that support the protocol, the bridge can also be used by teachers and researchers that use a different type of learning environment. Those other environments might also benefit from additional pedagogical flexibility and learning measures, or neither provide the tools for teacher-driven experimental comparisons, thus for those teachers and researchers the protocol can also come in helpful (e.g., Henrick, 2012).

The power of experimental comparisons in MOOCs, and other online learning environments, must not be underestimated. Reliable experiments in education are challenging, since the conditions of randomization and double-blinding are difficult to satisfy. Yet in online learning those conditions are much more easily satisfied, and its large scale provides the power to reliably discern the effects of different interventions (Kizilcec & Brooks, in press; Savi, Williams, et al., n.d.). Experimental comparisons in MOOCs thus create a unprecedented opportunity for improving their quality, ultimately ensuring a positive impact of MOOCs on higher education.

Finally, the significance of MOOC teachers that can themselves deploy experimental comparisons can neither be overemphasized. Moving away from the aforementioned domain-independent research on learning interventions requires teachers to have sufficient educational and pedagogical flexibility, including ways to thoroughly and reliably evaluate their course. The Qualtrics bridge provides MOOC teachers with the desired experimentation and measurement functionality, and thus potentially helps levitate the quality of MOOCs.

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