Learnersourcing of Complex Assessments

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Abstract
We present results from a pilot study where students successfully created complex assessments for a MOOC in introductory electronics – an area with a very large expert-novice gap. Previous work in learnersourcing found that learners can productively contribute through simple tasks. However, many course resources require a high level of expertise to create, and prior work fell short on tasks with a large expert-novice gap, such as textbook creation or concept tagging. Since these constitute a substantial portion of course creation costs, addressing this issue is prerequisite to substantially shifting MOOC economics through learnersourcing. This represents one of the first successes in learnersourcing with a large expert-novice gap. In the pilot, we reached out to 206 students (out of thousands who met eligibility criteria) who contributed 14 complex high-quality design problems. This results suggests a full cohort could contribute hundreds of problems. We achieved this through a four-pronged approach: (1) pre-selecting top learners (2) community feedback process (3) student mini-course in pedagogy (4) instructor review and involvement.

ACM Classification Keywords
K.3.1 [Computer Uses in Education]: Collaborative Learning.

Introduction

There are 4,706 degree-granting institutions in the United States. A specialized introductory course such as circuits and electronics is taken by 10k-100k students every year [8]. This gives 3-4 orders of magnitude inefficiency on tasks such as creation of lectures and assessments, and 4-5 orders of magnitude on per-student tasks such as grading. Open educational resources (OER) and at-scale learning organizations (such as MOOC providers) attempt to improve the quality of education by leveraging those inefficiencies to provide higher-quality resources at lower cost. The OER approach has met limited adoption due to lack of coherence – finding and adapting relevant and quality OERs is often more time-intensive than creating new resources [4].

In contrast, institutional Massive Open On-line Courses (xMOOCs) use a centralized approach where a single course team creates a complete, coherent course. xMOOCs are typically taught by top instructors, and many employ research-based pedagogies such as active learning, constructive learning, and mastery-learning [5]. They are further enhanced with data-driven techniques. Initial evidence suggests that well-designed xMOOCs can lead to high levels of student learning and satisfaction in both on-line and blended settings [3][5][1]. In contrast to OERs, xMOOCs are traditionally not open, and do not substantially leverage the creative input of external contributors. xMOOCs have been limited by to the high cost of creating evidence-based resources, combined with a lack of well-developed economic models.

Mitros [6] introduced a hybrid model of course creation where a central staff provides a common course skeleton, and a community of learners, educators, and researchers builds and improves on that skeleton. This approach has been shown successful across a range of areas such as student remediation, translation, subtitling, and peer grading of simple assessments, but as predicted in expert-novice literature [7], had lackluster results for tasks such as concept tagging or text creation. Cormier [2] piloted how this model may work in courses with a large community of instructors, such as an introductory physics course. More esoteric courses, as found at a university level, often do not have such communities.

In this pilot, we explore ways to source content with a large expert-novice gap. To do this, we first pre-screen students for ones who showed a high level of mastery in the MOOC. Second, we train those students in best practices for creating high-quality assessments. Third, we have a process by which those resources are improved based on both community and instructor feedback.

In order to maximize the expert-novice gap, we choose contribution of assessments to 6.002x, the MITx course in circuits and electronics. 6.002x has a small number of complex assessments involving design and analysis. To give an idea of complexity of those problems, most weekly graded assignments consist of three problems and one laboratory. Students self-report spending an average of 11 hours per week on the course (including ungraded work).

The creation of assessments is a complex process:

- Students are taught basic concepts, such as linearity and nodal analysis. A large part of the goal of the course is to begin to develop design intuition for how circuits work and physical intuition for realistic component values. Course creators must be familiar with a range of circuits in order to be able to find ones which illustrate concepts taught in the course,

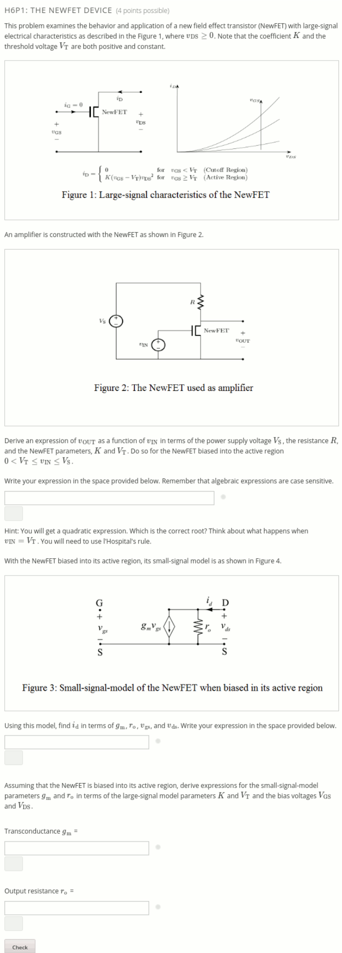

Figure 1: A representative mid-semester problem from the edX offering of 6.002x. Students are asked to analyze an amplifier based on a device they have not seen in the course.

and to be able to create simplified, realistic, variants of those circuits. Finding or creating interesting circuits is the bulk of the assessment creation time.

- Students can continue to work on problems until they reach a correct answer, and receive immediate feedback if they do not. Problems must lend themselves to automated grading, mastery learning, and infinite attempts (e.g. numeric and equations, rather than multiple choice or freeform pictures).
- Quality problem creation requires extensive pedagogical content knowledge.
- Problems should be fun and interesting.

An example problem from 6.002x is shown in Fig. 1. The complexity of this process is such that the assessment creation for the first run of 6.002x required 1.5 semesters of full-time effort from MIT instructors. Creating new exam problems is the major limiting factor on how often the course can be re-offered.

Process and Results

We e-mailed two groups of students:

- 106 students from the fall 2014 run of 6.002x (contacted one week after course completion) who achieved >97.5% on the final exam.
- 100 students from the original spring 2012 run of 6.002x who had achieved an 'A' grade in the course, and had volunteered to participate in such projects in the end-of-course survey (out of 2833 eligible).

Students were invited to participate in a short course about how to create good autograded assessments in introductory electronics, including content about pedagogy, capabilities of the platform, as well as subject-specific advice, such as finding good analog circuits to use as the basis of problems. Students were given a 10 day window within which to submit first drafts. Registered students were sent a reminder three days before this deadline. Assessments had three possible formats:

- Simple practice problems
- Mid-term exam problems (complex multiconcept)
- Final exam problems (complex multiconcept)

Students could submit problems either through the edX peer assessment tool, or the discussion forums. Students almost exclusively favored the discussion forum. Course staff and peers were active on forums, reviewing problems and providing feedback. Problems, on average, received 3-4 comments. This process was critical – few of the submitted problems were directly usable in the first iteration. Students and instructors formed a community in which they reviewed problems, learned from each other, and through the process, many of the problems improved dramatically. Several students indicated a very high level of value from participation in those forums, and found it helped for learning about both electronics and pedagogy.

At the time of the deadline, 57 students had registered for the course, and submitted a total of 17 problems, of which 2 were excellent as evaluated by the course staff[1], 12 were usable or excellent with relatively small tweaks or changes, and 3 were incomplete or unusable. Contributions and community continued beyond the deadline. The level of participation is typical of previous experiments in sourcing from MOOC students[6], but at a much higher task complexity. If we maintained similar

[1]Neither independent nor blind evaluation. The author of this paper is a co-creator of the course.

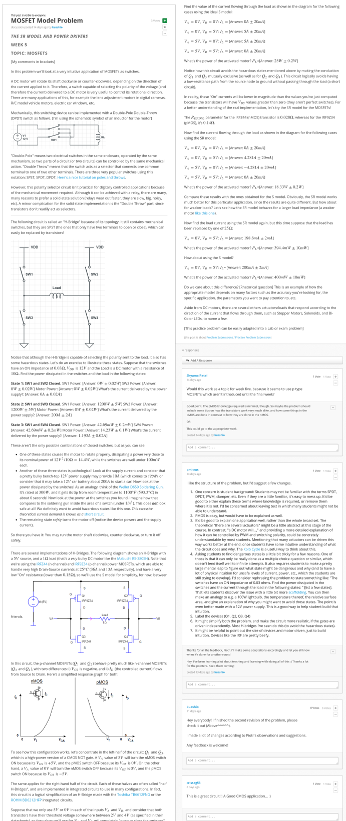

Figure 2: A representative problem contributed by a student, followed by the discussion around that problem. The problem walks through the design of an H-bridge driver. The author rewrote the first draft as a result of feedback.

levels of participation as we scaled out to more participants, we'd expect 28±6% to enroll in the course, and to receive problems corresponding to 30±12% of the registrants (25±11% usable problems). For all eligible students, the number of contributed problems would be many times greater than required for the overall course.

The problems ranged from simple single-concept practice problems to complex multiconcept problems based on real-world circuits, such as edge detector, a motor driver, an envelope detector, and a range of amplifiers, but most tended towards the more complex end. An example problem is shown in Fig. 2. In most cases, the very high quality was the result of the community process. Most of the initial submissions had good ideas, but suffered from any of a range of issues such as ambiguity, inappropriate level of difficulty, technical errors, and pedagogical short-comings. The community process allowed contributors to discover and resolve those issues.

Conclusion

We successfully demonstrated the ability to source complex assessments from MOOC learners. Since this was a pilot study, we used a small sample of 206 eligible learners. The results suggest that using the full cohort of eligible contributors would have allowed us to substantially accelerate the creation of complex assessments – the most resource-intensive portion of the course, assuming we were able to maintain similar contribution levels. A rough guess (with no data) is that the time spent per assessment is roughly an order of magnitude lower than fully manual creation, but also not zero, due to the need for review and editing. Based on the pilot results, learnersourcing appears to be a viable strategy for improving MOOC costs of creation, including those with a large expert-novice gap.

Acknowledgments

We thank all of the 6.002x students for their active engagement in both the course, and in community efforts to improve the course.

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