A New Model for Offering Construction Education on MOOC Platforms

Ali SHAFAA'T¹ and Farshid MARBOUTI²

¹ Purdue University, School of Civil Engineering, West Lafayette, IN 47907; PH (765) 494-2240; email: ashafaat@purdue.edu
² Purdue University, School of Engineering Education, West Lafayette, IN 47907; PH (765) 494-9713; email: farshid@purdue.edu

ABSTRACT
A new instructional medium called MOOC has recently become prevalent. Millions of learners from all over the world enroll in these available and affordable courses. Thousands of courses have been offered by distinguished institutes and instructors on a variety of evolving MOOC platforms. However, construction education has yet to take advantage of this popular medium. This paper offers a guideline for construction education to provide successful MOOC courses. Construction educators are already familiar with new educational technologies and active learning pedagogies. Combining these two familiar approaches can be a starting point for offering successful courses in MOOCs. This paper suggests using team-based and problem-based learning approaches along with the MOOC delivery in order to increase the success and completion rate, which has been problematic in MOOC courses.

INTRODUCTION
In this paper, we propose a pedagogical approach for Construction Engineering and Management (CEM) courses to increase students’ academic success in Massive Online Open Courses (MOOCs) by introducing a team-based model. This new team-based model increases collaboration, interaction, and accountability among CEM students in a course. This paper first looks at the theory and history of the MOOC. A review of studies on team-based and problem-based learning, new approaches to construction education and online learning provides background for the next section, which is teamwork in online settings with emphasis on the MOOC. Drawbacks and impedance for the marriage are reviewed and finally, solutions to these problems are proposed.

Massive Online Open-Source Courses (MOOCs)
MOOCs are supposedly built for a world where information is everywhere; in a digital world where Internet connectivity gives you access to a staggering amount of information (Heinic et al., 1999). It has been described as an open, participatory, and distributed course, which supports lifelong learning (Auletta, 2012). Though in the past, various methods of providing free educational content have done little to change the nature of higher education, MOOCs have been projected to have a much more significant influence on the traditional post-secondary educational system. This projection is largely based on the preponderance of information and communication technology, which serve as a medium to convey free educational content online. In this sense, the Internet is considered a vital resource necessary to facilitate and accelerate the transformation of the educational system.
In fall 2011, more than 150,000 learners registered for an online and open-source Introduction to Artificial Intelligence (AI) course in MOOC. For some, this was a harbinger of a drastic change in post-secondary education. Distance education programs (e.g. educational programs on TV) experienced the same appreciation during their epochs. However, the offered AI course faced similar problems as the prior free distance education courses, namely a low completion rate. Only about 13,000 (8% of the class) learners fulfilled all of the requirements. The 92% attrition in the class of one of the most well known professors in Robotics shows that MOOC needs much more than just interactive instructional media, communication gadgets, and free online content. In fact the main problem of MOOC, similar to other mass educational systems, is the lack of learner-instructor interactions.

The main difference between MOOC and previous free-distance education programs is the media. MOOC utilizes computers and the Internet, which enable students to interact with the content, each other, and the course instructor. While this can potentially increase learner-learner and learner-content interactions, main problems (learner-instructor interaction) still remained unsolved. Due to the high number of enrolled learners in the course, a high level of learner-instructor interaction is not possible. In absence of interaction with the instructor, students may feel less accountable to study. Furthermore, because of the large number of students in each course, instructors are not able to follow up with all students to make sure they have had enough progress in the course.

Another problematic part of MOOC is the assessment. Because of the high number of learners in a course, all quizzes and assignments have to be graded via computer, which mainly just allows for assessing students with close-ended questions such as multiple-choice questions. In most cases, these assessments are aligned with lower-levels of the cognitive domain of Bloom’s taxonomy (Anderson and Sosniak, 1994), which holds remembering at the highest level of understanding. In other words, only limited and lower-level cognitive capabilities of students are assessed. Additionally, computer-graded homework does not increase collaboration and contribution among students.

Team-based learning

Team-based learning was originally suggested to facilitate active learning in large classroom settings, though it has proven to be effective in a variety of instructional settings. One of the areas that team-based learning can be effective is in online learning. Lack of collaboration and accountability among students in online courses may lead to attrition in online education. In face-to-face education, use of team-based learning decreases the attrition (Knight et al. 2003) and increases class attendance, pre-class preparation, and academic performance (Michaelsen and Sweet, 2008). Thus team based learning can be used to increase interactions and accountability in online education and may increase completion of the courses.

Teams consist of a small group of students that have worked together over a period of time (typically 4-5 sessions). It is usually advised to keep the teams and not change team members for a semester or a year (McMahon, 2010). Due to this, student groups can evolve from small, awkward groups to coherent teams. In these teams, members better understand the course content and the team becomes capable of
solving complex and challenging problems that individual team members are not able to solve (Michaelsen et al. 1989).

Promoting teamwork via online discussions

One way to increase teamwork and interactions among learners in online courses is by setting up online discussion forums. Online discussions are being used in both blended (face-to-face courses with online components) and fully online courses to support collaborative learning (Allen et al. 2007; Luppicini, 2007). From a pedagogical perspective, in online discussions, students have the opportunity to engage in discussions with other students (Jonassen and Kwon, 2001) and negotiate their ideas to build an understanding of the course content (Boulos and Wheeler, 2007). These interactions enable students to explore, examine, and expand their thinking about course content (Hara et al. 2000; Guiller et al. 2008). This is especially important in fully online courses such as those offered by MOOC, because it is the primary medium of interaction between learners. Online discussion forums can facilitate collaboration among team members and increase interactions among classmates as already have been experienced.

Construction education

Construction education, similar to other fields, has been influenced by emergence of new educational tools, technologies, and pedagogies. A review of recent construction education papers in construction education conferences (e.g. CRC 2012 at Purdue University) reveals a high tendency toward using new educational technologies. Here are just a few examples of innovative works that is being done by construction educators:

- Use of interactive e-lessons in a construction management course (Kelting et al. 2012);
- Design and implementation of a web-based peer evaluation tool (Manry and Phoha, 2012);
- Developing an interactive visualization environment for construction engineering education (Messner et al. 2012);
- Introducing an interactive system for teaching construction management (Jafari et al. 2012);
- Developing a game for construction planning and scheduling education (Karshenas and Harber, 2012);
- Introduction of an online learning academy (Farrow, 2012);

Construction industry is a project-based industry (Fong, 2012). Thus it is not surprising that project based and problem based learning play an important role in construction education. In addition to using new educational technologies, there is also a trend to use new pedagogical approaches in construction education. Problem based learning (McIntyre, 2012; El-Adaway and Truax, 2012), project based learning (Kelting and Hauck, 2012), team based learning (Benhart and Koch, 2012) along with peer evaluation techniques (Bray and Manry, 2012), inquiry based learning, and
constructivist learning (Monson, 2012) are some examples of pedagogical approaches that have been utilized for construction education.

Among different active learning styles that have been implemented in CEM education, team-based learning is especially important (Benhart and Koch, 2012). As explained earlier in the paper, team-based learning can promote collaboration and interaction among learners (Fong, 2012; McIntyre, 2012). This is especially important in use of new technologies such as online learning environments. As mentioned earlier, one of the known drawbacks of online learning technologies is lack of interactions between instructor and learners and even among learners. Combining team-based learning pedagogies with online learning technologies may overcome the shortcomings these technologies and benefit the learners.

Although a few attempts have been made to marry new educational technologies and recent pedagogical approaches [e.g. virtual construction project field trips using remote classroom technology (Jaselskis et al. 2012)], for the most part, these two trends do not overlap. Since construction educators have the experience in both new technologies and pedagogies, a team-based MOOC, which offers construction courses, can be a place to use the benefits of both emerging trends in construction education.

**PROBLEM-BASED LEARNING**

As previously mentioned, problem-based learning is crucial for reaching the educational purposes of CEM courses effectively. However, instructional designers have some constraints in assigning problems. Some of these constraints are:

- **Course time span**: The students should be able to achieve a certain level of accomplishment by the end of the course.
- **Workload**: The problem should not be too resource-demanding.
- **Difficulty**: Students should be able to solve problems using the knowledge or ability they gain from the course content and its prerequisites.
- **Clarity**: As students may not have enough information about the course content in the beginning, problems have to be designed clearly and be explained adequately.
- **Grading**: The criteria for evaluation should be clearly predetermined.

Considering the fact that MOOCs are typically short-term courses which are open to whoever can access the internet and has the intention to enroll, the aforementioned limitations become more critical for instructional designers. There are numerous MOOC learners with diverse backgrounds and levels of knowledge who typically are not full-time students. One way to overcome these barriers is via teamwork, as it helps MOOCs via facilitating problem-based learning and increasing learning quality in several ways.

**Why team-based learning?**

As previously stated, learning success is highly correlated to the level of interactions between the learners and the content, their instructor, and their peers. In the social systems, the interaction levels are affected by interdependence levels among individuals. Wageman (1995) categorized the interdependence among people
Learning is influenced by pedagogy and assessment. In traditional classrooms, group projects and other team-based assignment increases the students’ interdependence in learning. In other words, traditional face-to-face classrooms have task interdependence among students due to a team-based learning process. Since learners in both systems have used the course materials and have access to the instructors, there is input interdependence in both systems. In MOOC, there are a variety of learners with different goals such as lifelong learners, skill-seekers, and degree-seeking students. Lack of a shared goal in addition to absence of team-based learning lowers the level of goal interdependence in MOOC courses.

The MOOC platform mainly relies on the constructivism theory in learning (Cabiria, 2012; Bell, 2010; Bremer, 2012). A departure from conventional control and assessment into more autonomy is what team-based learning brings to classrooms. Therefore, team-based learning would be a great help in achieving this goal to be a constructivist educational environment.

Interconnectivity of several human beings makes any system complex and MOOC classes are by no means exceptions. Teams, on the other hand, can be seen as controllable sub-systems, which have clear boundaries and outputs. MOOC courses rely on peer review for evaluating learners’ assignments, which cannot be auto-graded using computer software. Typically, learners are asked to do certain number of evaluations (i.e. peer review) for each assignment. Having teams reduce the need for peer reviewing significantly, as the number of evaluations per person would be fewer. This can also increase accountability for students. With the lack of interactions between instructor and students in online environment, students may feel less accountable to keep up with the course work. However, having peer reviews increases interactions among learners and may increase accountability. This is especially important in a team-based setting when team members are held accountable not only by the instructors but also by other team members to finish the assigned task. Finally, teamwork increases social connections. A sense of belonging to a community increases motivation for contribution in class activities.

In order for team-based learning to work in a course, Fink (2002) introduces two conditions: 1) “The course must contain a significant body of information and ideas (i.e., the content) that students need to understand”, and 2) “Students must learn how to apply or use this content by solving problems, answering questions, resolving issues, etc.” Most online courses in MOOC have the two described conditions, thus they are good potential candidates for team-based learning.

PERFORMING AS A TEAM CHALLENGES AND OPPORTUNITIES

Although teamwork seems very promising, in a framework like MOOC, reaching proficiency in team work is quite challenging. According to Brue Tuckman’s model (1965), performing as a team would be possible after three other steps named: forming, storming, and norming. During team forming, there is not much agreement about aims, roles, and responsibilities. At this stage, team members only rely on guidance, regulations and available directions. Here, members are on their best behavior, though they do not produce anything like with team output.
The storming phase starts when team members start building relationships and conflicts arise when personalities, attitudes and goals are revealed, as there may be struggles over power, working style and timing. Clear goals and guidance can help team members to pass through this phase faster and after experiencing conflicts, members reach a consensus. In the norming stage, members know other teammates’ level of knowledge and skills, and as a result, leadership and working style are agreed on and team cohesion and shared understanding have noticeably increased.

After going through these stages, teams start performing, meaning that they start accomplishing tasks without much guidance from outsiders. This is because members have reached certain levels of agreement, understanding, and acquaintance and members can resolve inter-teams conflicts. In performing tasks, members depend on each other in various degrees and a great amount of interdependence needed for more interaction and coordination among members. In the next section, barriers to team work in MOOC platforms will be investigated.

MOOC barriers in team-based learning

In the previous section, the definition of a team process and a description of how teams start performing were given. Before designing teams for a MOOC platform, limitations and problems have to be identified. In this section, major shortcomings will be discussed and in the next section, solutions for overcoming these barriers are proposed. Problem-based and team-based learning in MOOC have some problems in common while the solutions are different.

Time (course duration) is a common issue between problem-based and team-based learning. Teams have to go through forming, storming, and norming stages to start performing and these stages require time and guidance. Without clear instruction, group members may get stuck in a stage, though with clear direction, team members would pass faster through the aforementioned steps and start performing.

Other learners’ affiliations are not just a problem for MOOC, it is a pervasive issue in e-learning in general, though it is more serious in MOOC because of the barriers it causes for coordination. During team forming, learners heavily rely on communication to know each other better and if team members are busy and do not reply to each others’ messages, real teams will not form, though the learners are technically a part of an assigned “team”.

Lack of trust is a common issue in virtual team working and it can be more serious for e-learning teams in a platform like MOOC due to the ephemerality of teams, goal inconsistency among learners, and lack of information about teammates. Trust in the virtual environment establishes quite slowly and limitations on accessing teammates’ personal information make the situation even worse. Additionally, since learners know that the attrition rate is very high in MOOCs and there is no penalty for such behavior, then teammates may cease collaboration at any point. In virtual teams, trust develops based on more identifiable actions, such as timely information sharing, appropriate responses to electronic communications, and keeping commitments to the virtual team (Jarvenpaa et al. 1998).

Different learners may enroll in the class for a variety of reasons, such as course title, name of the offering institute, thirst for knowledge, or earning a
certificate. As mentioned before, goal inconsistency among learners reduces trust and goal interdependence and because of this, less interaction is expected.

Although many expect digital natives to perform well in MOOC, teamwork in virtual settings would be hard without previous experience and would be even harder for those with less proficiency in online interactions. Ambiguity on some of teamwork features and differences in different software exacerbate the situation. Again, it should be considered that MOOC learners only have limited time for learning.

Communication problems can have different roots, such as language barriers, cultural issues, time zones, and limited internet access as well as previously mentioned problems including; deficiencies in virtual team work or lack of trust. Additionally, electronic communication can exacerbate conflict (Zhang and Ge, 2006). When team members simply refuse or delay to respond, it can impede the formation of group consensus (Warkentin, and Beranek, 1999) and increase the potential for bad first impressions. On the other hand, online video communication channels (Zhang and Ge, 2006) like Skype can amend the quality of communication.

Knowledge sharing is yet another prevalent problem in teamwork. In any team, members may be reluctant to share creative but potentially divisive ideas (Furst, 2004) with team members since it is hard to gauge the potential reactions. Establishing procedures at the stage for information sharing can alleviate the problem (Rosen et al. 2001).

Any combination of the aforementioned problems can impede teams from truly forming or reaching consensus norms. In order for teams to perform well, they have to be designed precisely and the following section is dedicated to criteria that have to be met when designing teams to achieve the desired level of performance. The next section tries to use the flexibility of MOOC platform to overcome these obstructions.

**What is the solution?**

While MOOC can cause some problems for teamwork, its flexibility (Cabiria, 2012) can be of much help. One way to deal with some of the problems mentioned in the previous section is via different levels of involvement. Several MOOC courses have provided the option for learners who want to audit the course to enroll as an audit (Cabiria, 2012). Thus they can be differentiated from those who are seeking the certification. There are other courses that even went further and proposed two types of degrees, one for those who are willing to spend more time and those who just want the certificate and do not have enough time or intention to delve more into the material.

Using software for team assignments is one strategy which speeds up team formation, while also reducing confusion and the feeling of being abandoned. Without software, learners must manually form teams and ask others to join them, or learners have to ask others to invite them to their teams. This is not efficient in large classes, such as those in MOOC, and is a time-consuming process because learners do not know each other and may feel abandoned or annoyed if they cannot join a team. Language preference, time zone, and several other factors can be used in assigning members to a team. Uploading material a week earlier is another strategy which gives
learners time to consider how serious they really are and allows communications to occur without any pressure.

Persuading teams to meet using video communication channels reduces first impression problems and increases trust. Although there may be some learners who are reluctant to appear in online live discussions, for others it may be a great way to increase team cohesion and facilitate future information sharing. There are other ways to ask learners to share certain amounts of information, though these cannot be mandatory. One method which is utilized in other courses is sharing resumes and receiving feedback. Another method can be using team assignment software, which does not allow learners who do not reveal their identity to be in the same team with those who shared their information. Providing detailed examples would serve as useful instruction in team work. These recommendations will help course designers to facilitate team working in their MOOC courses.

CONCLUSION
This paper does not intend nor is able to recommend MOOC courses as substitutes for conventional courses. However, MOOC is able to bring autonomy, diversity, openness, and interactivity to the learners’ community in the Construction Industry. In this paper, we discussed ways to enhance this experience by introducing problem-based and team-based learning. What is suggested in the paper can help course designers to go beyond online lecturing and increase interaction, success, and the completion rate in their courses.

REFERENCES


