Supporting Service Member Transition into Academia: MOOCs on Engineering Fundamentals

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Background

Massive open online courses (MOOCs) are classes with open access to any individuals through the world-wide web. The term MOOC first appeared in the late 2000s. This large, unlimited participation in online courses became a popular educational delivery method in the early 2010s. The authors believe these learning materials have a place in education and are quite revolutionary. But the authors don't think MOOCs will replace the richness of the educational learning environment that student receive in an on-campus experience. The lead author, Wayne Whiteman, currently offers eight MOOC courses on the Coursera platform. They are offerings in the fundamental engineering topics of Statics, Dynamics, and Mechanics of Materials. The first course went live online in February of 2013. MOOCs provide access to quality learning material to large numbers of individuals who may not otherwise have the resources to receive this level of education. They also provide a valuable resource to individuals transitioning into the academic environment, such as high schoolers or military service members who are completing their time in service and want to attend higher level education institutions. While there is not yet any direct evidence that MOOCs are significantly affecting veterans transitioning to college, the authors believe that this resource will contribute to this military-to-civilian transition in the future. The MOOC courses studied in this paper are excellent preparation for future students in engineering disciplines such as civil engineering, mechanical engineering, aerospace engineering, and material engineering. This paper provides details on the MOOC course format. Statistics on course enrollments are included. Student demographics, such as age, gender, and educational background are provided. The country of origin for students and the percent participation for these countries are given. Survey feedback results offer insights into many of the issues associated with this type of distance learning. Observation and assessment tools are discussed. And finally, the authors' thoughts for the future with regard to massive open online courses are provided.

MOOC Course Format

The eight engineering MOOC courses addressed in this paper contain the same content as fundamental courses taught as part of an on-campus curriculum in a number of engineering disciplines. The Statics class taught at Georgia Tech is a 2 credit hour course. The "Introduction to Engineering Mechanics" and "Application in Engineering Mechanics" MOOCs address the topics associated with the 1st and 2nd credit hours, respectively, of the on-campus Statics class. The authors have found, for basic engineering classes, that the rule of thumb is one hour of on-campus credit equates to approximately the amount of material that can be organized into a single MOOC offering.

The MOOCs, "Engineering Systems in Motion: Dynamics of Particles and Bodies in 2D Motion" and "Advanced Engineering Systems in Motion: Dynamics of 3D Motion," contain the same content as are typically delivered in our on-campus Dynamics course at Georgia Tech. The topics covered in the on-campus 3 credit hour Deformable Bodies class (sometimes referred to as

Mechanics of Materials or Strength of Materials at other universities), is contained in the MOOCs; Mechanics of Materials I: Fundamentals of Stress & Strain, Mechanics of Materials II: Thin-Walled Pressure Vessels and Torsion, Mechanics of Materials III: Beam Bending, and Mechanics of Materials IV: Deflections, Buckling, Combined Loading, & Failure Theories.

The typical format, for the engineering MOOCs discussed in this paper, is 5 to 7 weeks long. Each week there is a total of about 5 to 8 video modules. Each of these modules are approximately 5 to 10 minutes long, on average. In creating these materials, topics were partitioned into these "bite-size" sections for effective delivery. For assessment a quiz is included at the end of each week's material. There are no assigned textbooks for the MOOCs, although suggestions are offered. Suggested references include two textbooks that were used in developing the Statics and Dynamics MOOCs [1], [2].

All the MOOCs discussed in this paper are offered through the Cousera platform (www.coursera.com) From 2013 to 2014, these courses were offered as "session-based." The timing was typical of an on-campus format, with published start and end dates and "hard" deadlines. Since 2014, the MOOC format has changed to "on-demand." Students are allowed to enroll and start at any time. New class "cohorts" start about every month for every class. These courses are self-paced with "soft" deadlines. The deadlines are suggested, but if the student falls behind they may join up with the next month's "cohort" and continue to proceed in the class until completion.

In-video knowledge checks are included in the module videos to stimulate learner interaction. The video pauses at various locations to allow students to reflect and answer questions on their own about the material. An example of this type of interaction is included in Figure 1.

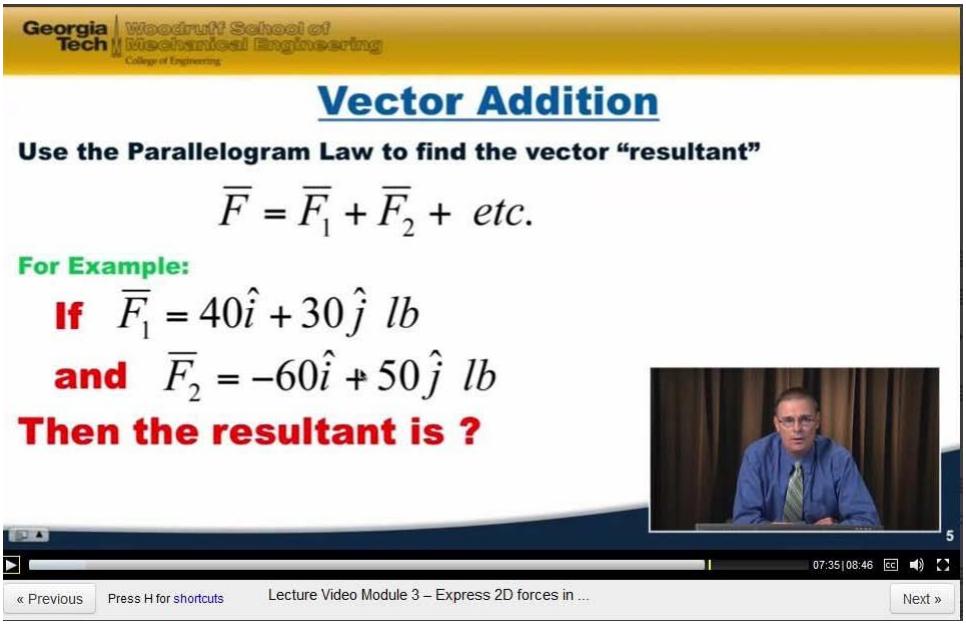


Figure 1. Typical In-Video Knowledge Check

Enrollments

Approximately 48,000 students were active learners during the session-based offerings of these 8 MOOCs. Additionally, over 205,000 active learners have engaged with these courses since the implementation of the on-demand "cohort" format. "Active learners" are defined as those students who have actively engaged in the course materials; for example completing worksheets, or at least one quiz in the class. The number of students who merely visit these on line courses and do not engage are about twice the more than 250,000 students who have been active in the courses. The weekly new enrollments of these 8 MOOCs are about 750 to 1000. For the past several years, enrollments increased in a linear manner.

Completion rates of the MOOCs are quite low, typically a little less than 10% for the active learners in the course. But the feedback in the discussion forums of the classes reveals that many of the students do not have a desire to complete the entire course. These students are typically looking for very specific material to perhaps supplement a current on-campus course they are completing at another university, or reviewing material as a graduated engineer who is brushing up on their fundamental engineering skills.

Student Demographics

Figure 2 shows the typical ways that students characterize themselves. Roughly 50% classify themselves as current students at the undergraduate or graduate level. About a quarter of the students refer to themselves as industry professionals. The remainder fall in a number of other categories as shown. This latter category, along with the professional group, seems to align best with individuals potentially transitioning into the academic environment, such as high schoolers or military service members who are completing their time in service and want to attend higher level education institutions. In these cases, these MOOCs can serve as a valuable educational resource for these individuals' current life goals.

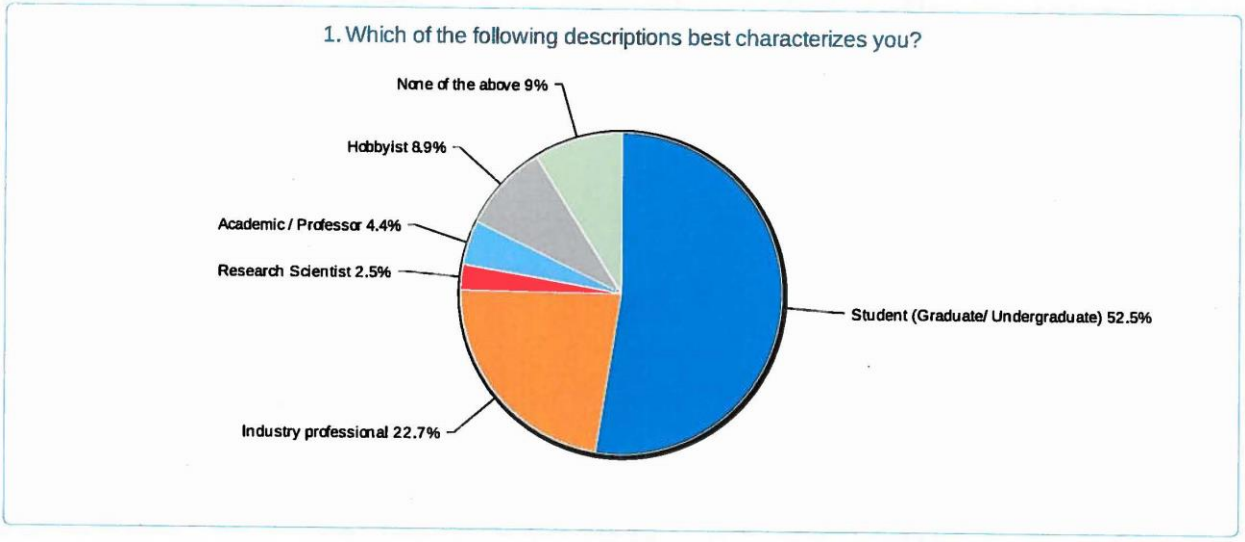


Figure 2. Typical Student Categories

Student educational background is shown in Figure 3. As shown, over 50% of the learners have a bachelor's or master's degree. A little over a quarter of the students have a high school education. Surprisingly, nearly 5% of all of the learners in these eight engineering MOOCs hold a doctorate.

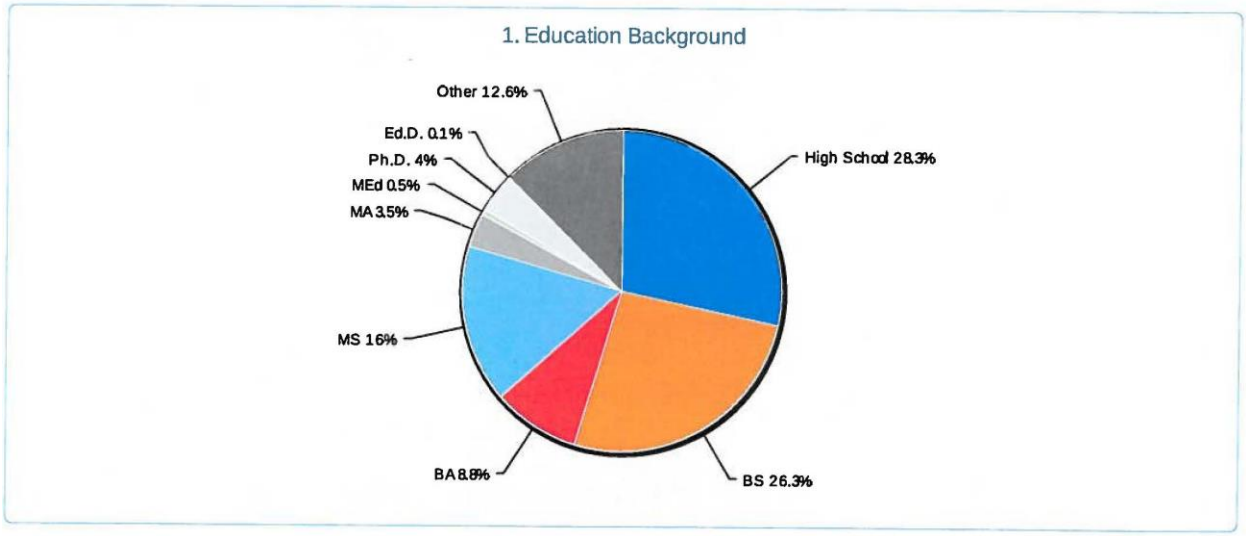


Figure 3. Student Educational Background

Figure 4 shows a breakdown of students by age and gender. Comparisons are shown with general statistics about all Coursera learners in all disciplines. Much like is seen in engineering programs at university settings, about over 80% of the students in these engineering MOOCs are male, with less than 20% females. The overall population for Coursera MOOCs are closer to 55% male and 45% female. The largest age bracket for these eight MOOC engineering courses is 20 to 29, with 46% of the participants. When combined with the 30 to 39 age bracket, the total percentage of learners between the ages 20 and 39 are about 68%, or over 2/3rd so the total population. The remainder of the age groups are depicted in the figure.

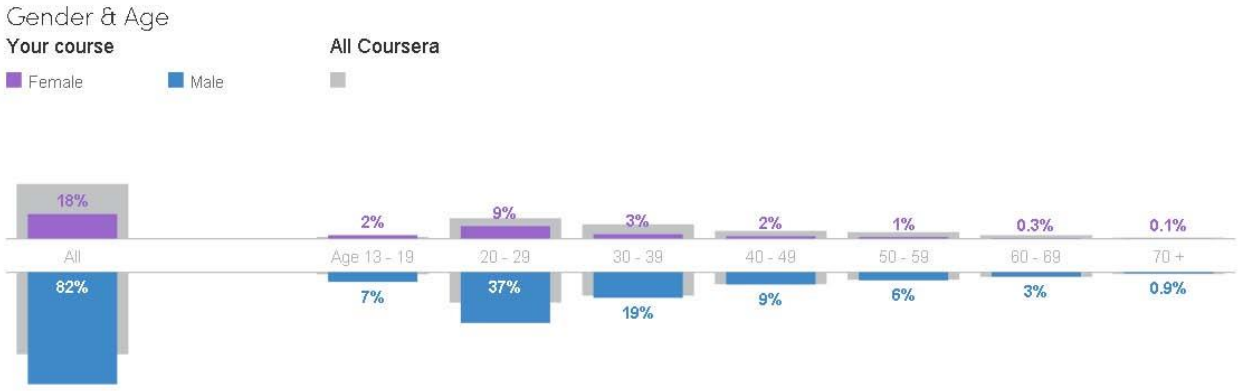


Figure 4. Typical Student Age and Gender

Students in these fundamental engineering MOOCs come from around the globe, representing over 170 countries in the world. The largest populations come from the continents of Asia, North America, and Europe. The top country representations are from the United States, India, China, the United Kingdom, Brazil, Canada, Egypt, and Spain.

Survey Feedback Results

Reviews are collected directly on the Coursera platform. Student feedback results are tallied in the form of ratings, based on a 5-star range (5 being the highest rating). The Mechanics of Materials III: Beam Bending MOOC receives the highest rating with 4.9 out of 5 stars. The lowest rating is in the "Introduction to Engineering Mechanics" MOOC with 4.7 stars. The remaining 6 MOOCs receive a rating of 4.8 stars. Written comments are also provided on the Coursera web site for each course in the review section.

Specific survey results are also collected in each of the individual courses by xxxx xxxx. Regarding the overall quality of the course materials, roughly 90% of the students rate the material "excellent" or "good." Seven percent state that the material is "fair." Three percent rate the material as "poor."

Students are also asked how the MOOC course changed their perception of the university/institution offering it. Nearly 80% of the learners state that they view xxxx xxxx "more favorable" or "much more favorable." Twenty-Eight percent rate "no change." 2.5% state "less favorable."

"Class Central" (www.class-central.com) is a giant curated catalog of MOOCs spread across different online course providers. They focus on quality, and manually categorize and tag every MOOC. There are tens of thousands of reviews written by learners. To date, over six million learners have used "Class Central" to decide which online course to take.

"Class Central" is a dynamic web site, so it updates in real time as MOOC ratings change. Recently the eight engineering MOOCs discussed in this paper occupied the top 4 slots in the highest rated MOOC in the engineering discipline, and help 7 out of the top 10 positions. One of the MOOCs, "Introduction to Engineering Mechanics," was cited as one of Class Central's Top 50 MOOCs of All Time (2017 Edition) [3].

The amount of time students spend on the MOOC courses is depicted in Figure 5. As shown, 50% of the students expected to spend about 4 to 6 hours per week in the courses. Between 40 to 50% of the learners actually find themselves spending that much time. The time above and below these ranges are about evenly split. Interestingly, Figure 6 shows that 82% of the students felt that the workload was appropriate. A little over 15% said there was not enough work, and only 1% stated they felt there was too much work. The graphs in both Figures 5 and 6 were assembled from self-reported data that was collected in surveys that learners completed while taking the course.

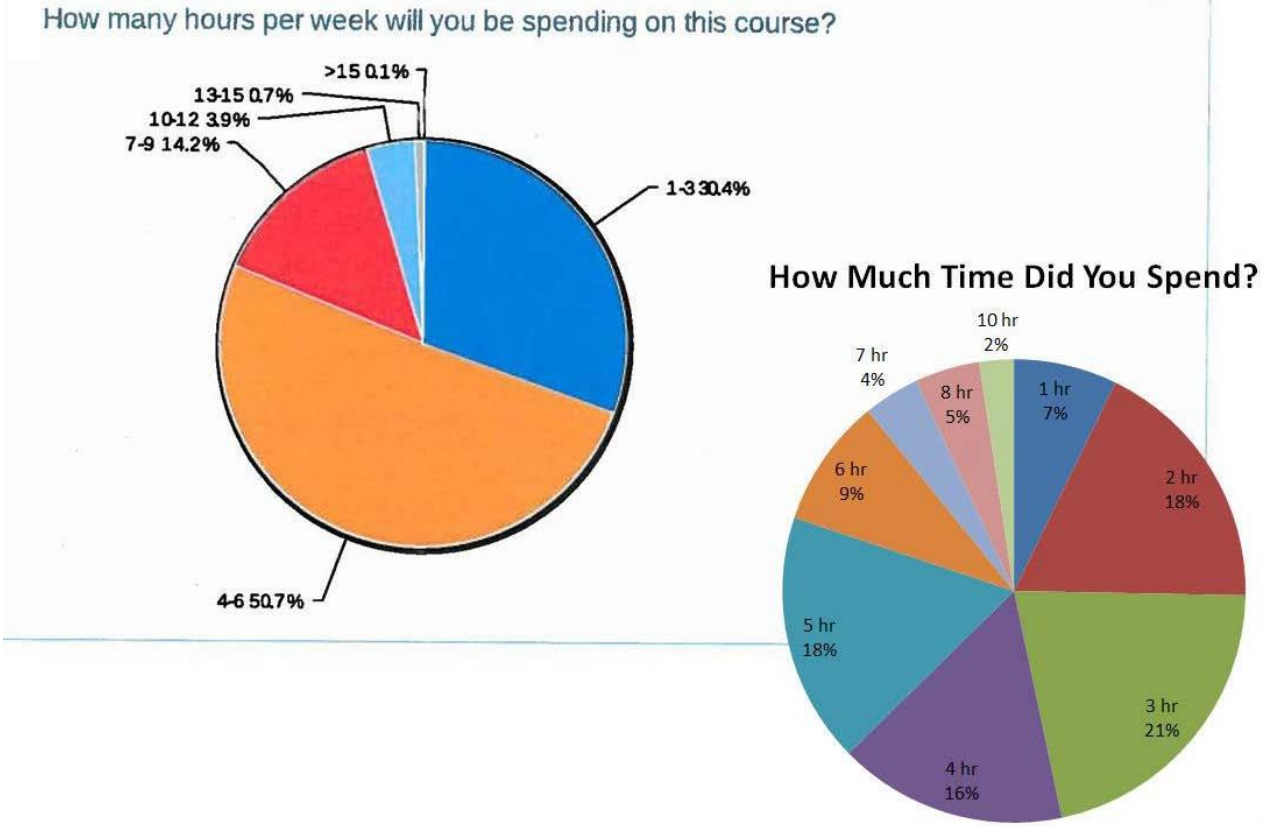


Figure 5. Time Expectations

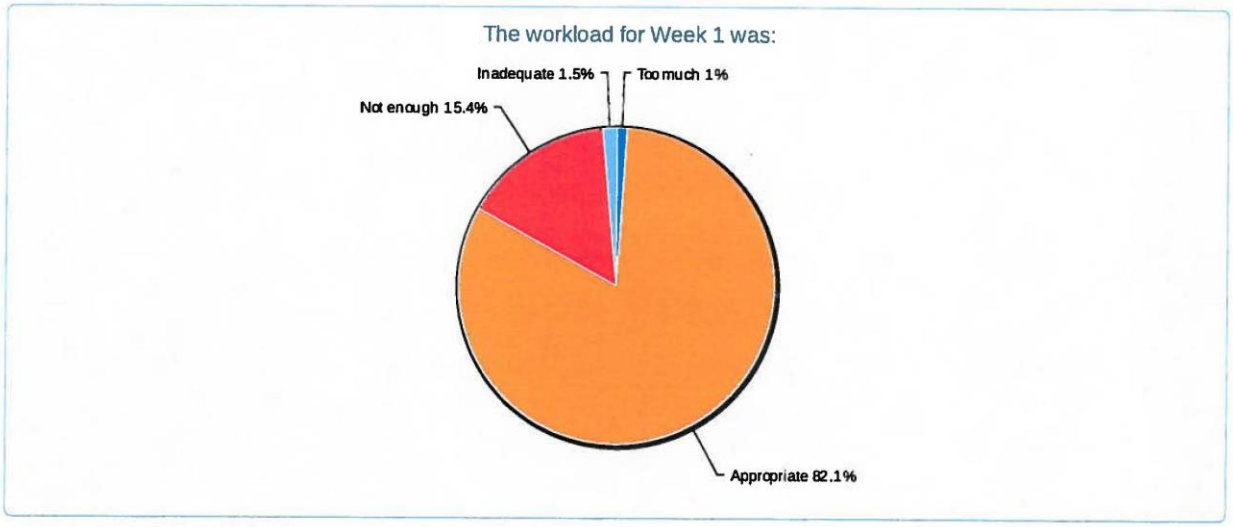


Figure 6. Workload

Observations

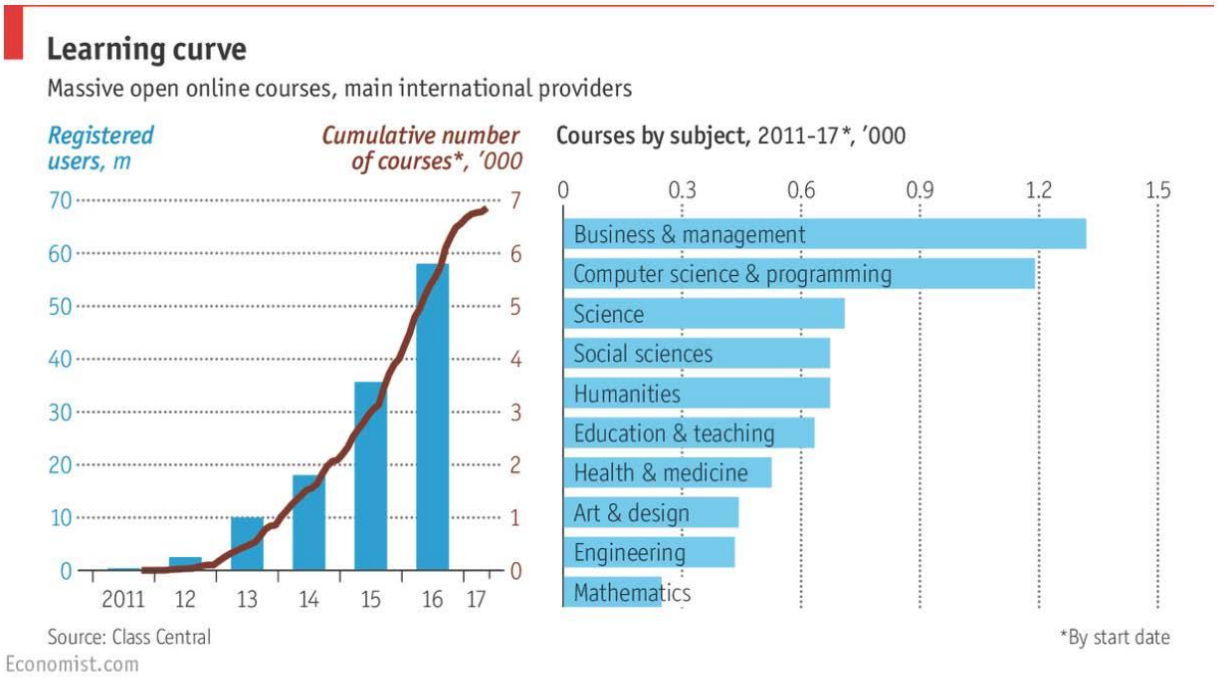
From an instructor perspective, it takes a large amount of time to develop and produce a MOOC. The authors estimate that it takes about 300 to 500 hours of work to complete the delivery of one MOOC. As noted earlier, one MOOC is about 30 to 40 videos and covers the content of about one credit hour of on-campus material.

For assessments in the quizzes, multiple choice questions are used. Pedagogically the authors are not in favor with this approach, but it is impossible to individually grade thousands of quizzes. The multiple choice approach allows automatic grading and provides students immediate feedback with their results.

Once the MOOC is complete and live online, the amount of time required by the instructor to be involved in the course is greatly reduced. The main task, which is not required, is to check the course discussion forums every few days. The instructor need not answer all of the questions in the discussion forums however. Volunteer course mentors help students, as well as students helping each other to collaboratively learn in the classes.

Future of MOOCs

As of 2017, nearly 70 million registered users have accessed the major MOOC provider web sites world-wide. Nearly 8,000 MOOC courses are offered across several disciplines. Engineering is one of the smaller subject areas, with between 400 and 500 courses [4]. Figure 7 shows these results and Figure 8 graphically portrays the top 5 MOOC providers in the world [5].



CLASS CENTRAL

Source Class Central via the Economist

Figure 7. Massive open online courses, main international providers

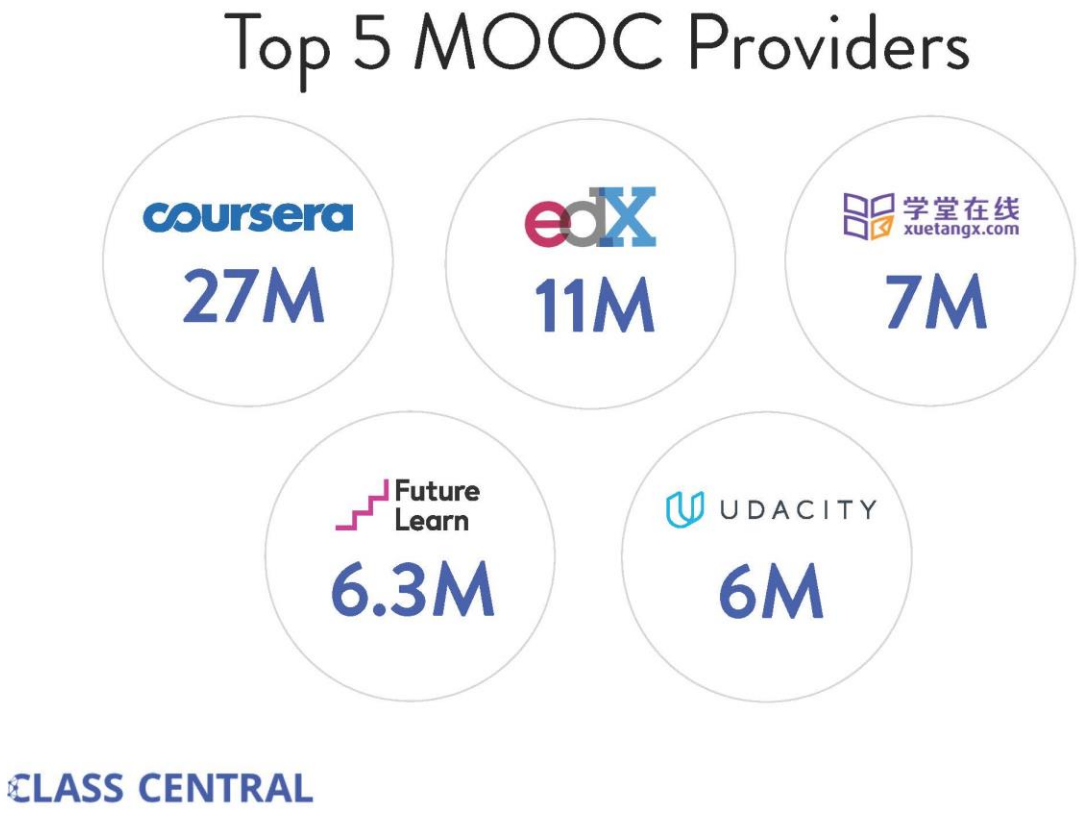


Figure 8. Top 5 MOOC Providers

It appears that the business model for MOOCs is still emerging. With its more than 27 million users, Coursera charges a fee for MOOC completion certificates. And some MOOCs are offered as a specialization of several individual courses with a capstone experience. In addition, at the end of 2017, Coursera began testing a subscription service business model.

In the opinion of the authors, MOOCs are enhancing, but not replacing, the on-campus learning environment. In many courses at Georgia Tech, these MOOC modules are being used to flip and blend classes. Student complete certain modules in advance of class, and then more engaged learning takes place in the classroom.

The authors believe that on-campus teaching craft must add value to the educational experience beyond the material content offered via online courses. Schools should focus on the rich interactions that a university environment provides, such as maker spaces, research and teaching labs, engineering competition teams, etc. It's important for universities to incorporate, where appropriate, rapidly emerging technology.

Conclusions

In conclusion, MOOCs are a resource that allows the presentation of learning material to large numbers of individuals. These online courses are a valuable resource to groups who might otherwise not have access to this material around the globe. It can also be useful for high schoolers transition to college, or former military service members who are transitioning into academia. While there is not yet any direct evidence that MOOCs are significantly affecting veterans transitioning to college, the authors believe that this resource will contribute to this military-to-civilian transition in the future. There will always be a place for high quality on-campus teaching and a rich learning environment. But things are changing rapidly, and universities must take advantage of the opportunities distance learning resources can provide.

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