Gender and Diversity in Engineering MOOCs, a first Appraisal

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INTRODUCTION

Massive Open Online Courses(MOOCs)are a relative new phenomenon, which has attracted much attention due to the speed of development and the propelling effect for the discussion on educational innovation. Especially the emergence ofnew models for education has spurred the debate with the MOOC as the potent defense against the increasing debts of students, the rising cost of education, the insular culture of Higher Education, the ability to offer large audiences lectures at no cost and a high level of flexibility [1]. The promise of MOOC is to have an important impact in improving teaching and learning and encouraging institutions to have distinctive missions. Therefor it is a viable cause to investigate what characteristics a

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MOOC might have in relation to gender and diversity (e.g. age, educational or professional background) in engineering courses.

Especially the underrepresentation of women in engineering sciences in traditional, campus based education is a well-known and vastly discussed fact[2].But what happenswhen the classroom is virtualised and students from all over the world can participate freely and open in suchMOOCs? In other words how well are students doing in engineering MOOCs and what is the relation with questions concerning gender and diversity?

This paper addresses the participation and performanceof MOOC students in relation to gender and diversity. It is a first appraisal based on the data collected from the five engineering MOOCs executed in 2013-2014 at the Delft University of Technology (TUD) on the edX platform, which is part of the edX consortium (www.edx.org).Chapter 2 gives an overview about previous research outcomes. In chapter 3 the data collection from TUD is summarized under the special focus on gender and diversity. In chapter 4 the authors of this paper present the outcomes of the data analysis with a focus on gender and diversity of student population in relation to participation and performance. Chapter 5 summarizes the outcomes and gives an outlook to further educational and research questions in this field.

Table 1 shows an overview of the MOOCs at stake of which some have a rerun in the season 2014-2015 and are used in addition to online courses, campus courses or in a mixed mode often in a flipped classroom format. They comprise a mix of topics, are generally based on existing campus courses, ran for six to eight weeks and attracted almost 140.000 registrants with a completion average of 3,7 % and were all on a bachelor level [3].

Table 1.Overview of the first generation of DelftX MOOCs (2013-2014)

MOOCs	Period	#Students	# Completers	Level
#1 ET3034TU Solar energy	16.09 – 6.12.2013	57.091	2.730 (4,8%)	Bcs
#2 CTB3365 Introduction to Water Treatment	16.09 – 25.11.2013	29.088	545 (1,9%)	Bcs
#3 1110X Introduction to Aeronautical Engineering	03.03 – 19.5.2014	15.820	578 (3,7%)	Bcs
#4 TW3421 Credit Management	18.04 – 30.6.2014	20.925	709 (3,4%)	Bcs
#5 NGI101x Next Generation Infrastructures	23.04 – 8.7.2014	16.091	517 (3,2%)	Bcs
A total of		139.015	5.079 (3,7%)	

MOOCs contain a new data context with a mix of systems data, survey results and interviews. For this research the focus was on data concerning learning demographics and in particular on gender related issues.

2 LITERATURE REVIEW

2.1 The MOOC Phenomenon

A MOOC is an online course aimed to provide free access to university level education for as many students as possible. MOOCs differ from traditional university online courses in two ways: 'Open access', anyone can participate in an online course for free, and 'Scalability', courses are designed to support an indefinite number of participants. They can be seen as an extension of existing online learning approaches, in terms of open access to courses and scalability and a design that allows for large-scale feedback and interaction.

In the last couple of years MOOCs have developed into a broad spectrum of learning approaches with on the one side the so called xMOOC that represents predominantly a knowledge transmission model and is in essence considered to be technology-enriched traditional teacher-centered instruction. The xMOOC is less likely to have an innovative approach to learning. On the other end of the spectrum is the cMOOC with opportunities for non-traditional forms of teaching approaches,a learner-centred pedagogy and a strong focus on collaboration and social learning activities. The first generation of TUD MOOCs discussed here are xMOOCs, but with different participatory features when it comes to communication and collaboration[3].

One of the reasons why MOOCs have gained so much attention is the promise that they potentially will be able to revolutionize access to education. So farthe findings at the TUD confirm that MOOC participants come from everywhere, but mainly from the US and from India. The majority is well educated and already has a bachelor's or master's degree.With an average of only 3,7% completers per course, it is clear that a selection is taking place and not everyone is capable of doing such courses on Higher Education level for whatever reason [3].

2.2 MOOCs,Gender and Diversity

The objective of MOOCs is to offer open and online learning for everybody for free. But how does this look like in practice? The promise in terms of growth and internationalisation is something MOOCs seem to be able to keep [4]. Figure 1 illustrates an overview of the increase in the number of MOOCs over the last three years.

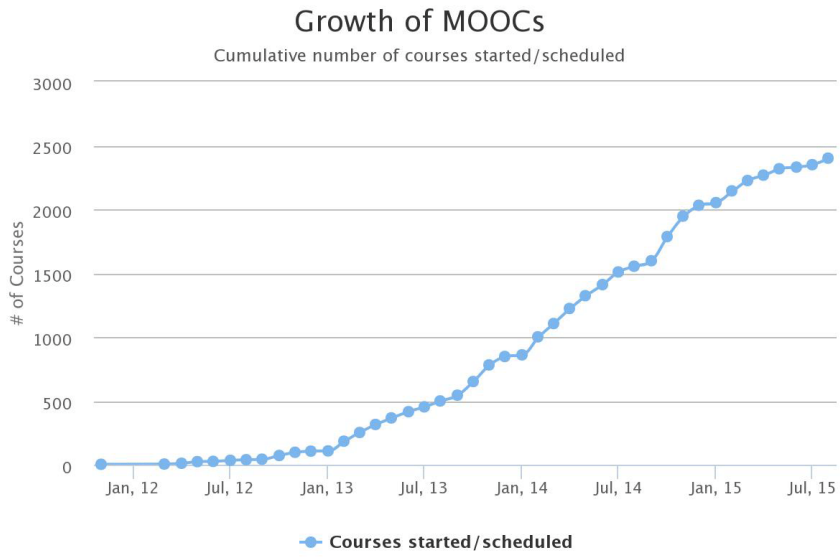

Fig. 1.The Growth of the Number of MOOCs (2012-2015) [4]

In comparison, table 2 shows the number of students per MOOC provider at the end of 2014. Clearly the numbers run into the millions with the US based providers as Coursera and edX on the top of the list.

Table 2.Number of Students per Provider [4]

Provider	# of Students
Coursera	10.5M
edX	3M
Udacity	1.5M
MiriadaX	1M
FutureLearn	800k

In this context, the question arises to what extend these providers serve the different course subjects which can be found at regular universities? Figure 2 shows the distribution of course subjects. What can be seen is that engineering holds a share of 5.2% of the total. This has evoked some debate whether MOOCs can be as useful for teaching humanities and non-technical subjects as it is for computer science and math. From the overview of the course offerings, there seems to be a healthy balance of technical and non-technical subjects [4].

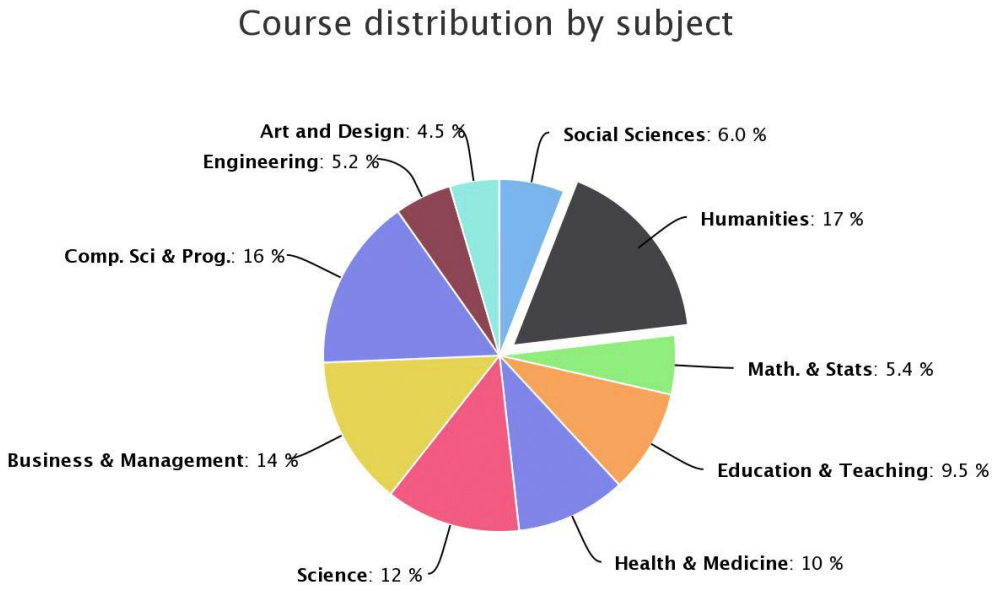

Fig. 2.Course distribution by subject [4]

The numbers look promising, but that does not mean that MOOCs have already entered the main playing field of education. As Grajek*et al*. [5] showed for the US undergraduate student population almost three quarters have never heard of MOOCs. He also states that the number of those who have taken a MOOC course is the highest among Asian students and significantly higher for men than women. This leads to the hypothesis that MOOCs are more interesting for men than women and might also have a bias of self-selection among students concerning ethnicity and/or cultural background.

Looking at the current offerings from a more pedagogical point of view Lehmann [6] concludes, that MOOCs tend to be behind the state of the art of didactics and are

mostly ignoring the experiences and concepts which were made and developed already for Open Universities and distance learning. These results turn them into spectacles for the masses with high entertainment aspects instead of education for the masses as intended and proclaimed. In this context it is interesting what Martin [7] observes while looking at the role of the teacher in a MOOC. For her, the role of the teacher in a MOOC is a stereotypical leader role, such as it is in a very large lecture, and therefore, the assumptions on social role and gender (or other diversity) stereotypes of the teacher could have a significant impact on evaluations. She presented the case of large courses and how female faculty receives lower positive evaluations in regards of their teaching compared male faculty. The role incongruity of female faculty is enforced and reduced to stereotypes of women teaching more nurturing than men. These effects are going to be intensified when we are looking at MOOCs, as their impersonal and mediated, remote nature is likely to boost and intensity gender (or other diversity) stereotypes of students and torpedoes the opportunity for the Western World to “export valuable female role models of authority and leadership” [7:15] to developing countries where they would help to encourage and empower girls and women as valuable customers of MOOCs. Martin [8] therefore expects MOOCs to become (another) male predominated area of academiaby this. This foresight is strengthened by statistics about MOOCs today. Most courses are taught by male academics, which is not to be explained by the fact that most MOOCs are from fields with low percentages of female faculty members, because even in fields with higher female percentages, the vast majority of open online courses are taught by men [7, 8].

To conclude the literature review at this point, the tenor of studies and papers on MOOCs tend to focus on didactic and methodologic questions, or on the questions of the open access of MOOCs, rather than taking an in-depth look at the current MOOCs student population, their performance and success linked to gender and diversity factors. Further research is strongly advised. The objective of this paper is therefore to enhance the discussion by a focus on data that relate to gender and diversity issues. It gives a first insight into the open question if gender and diversity dimensions show affects in participation and performance.

3. DATA COLLECTION

MOOCs unite diverse learners of various cultures, motivations, education levels, and age levels. Therefor in the initial stages of the research we opted to first focus predominantly on learner demographics that would clarify some of the peculiarities of social learning and collaboration in MOOCs: the multiculturality of the learning environment and the gender and diversity of its student population in relation to participation and completion. To this purpose a multi-layered setting for data gathering was developed for the DelftX MOOCsallowing for the collection of a substantial amount of data for analysis (see table 3).

The focus and interest of this effort concerning MOOCs was twofold. In the first place the evaluation should deliver basic quantitative information about the number of participants, dropouts and completers and the progression of these numbers and achievements during the course. Secondly the intention was to gather qualitative information that would help to better understand the behavior of the students [9].

Table 3. Data sources, instruments and information categories

Data sources & Instruments	Information categories
edX subscription data	Number of participants, dropouts, location, age, gender, schooling
edX student data	Progress, tests results, quizzes, exams, etc. Forum participation
External data, other media (i.e. Facebook groups, discussions)	Social networks, content and discourse analysis
Surveys (pre, mid, post): students	Information about demographics, intention, expectations, satisfaction, media use, etc. Interventions embedded in surveys
Semi structured interviews: teachers, NMC, DelftX	Experiences with workflow and organization Questions and expectations for evaluation

4 OUTCOMES

The collected data have been analyzed with the special purpose to gain insight in the issues regarding gender and diversity in MOOCs. Although the number of data and the quality are very satisfying one ought to be careful in interpreting the outcome, because from a research point of view this is a first appraisal. As said the MOOCs and their population require a higher number of analyses to come to general conclusions, but we consider this endeavor as a good step forward.

Looking at the outcome of the research it confirms the findings of Jordan [10} and MacLeod [11] that the ratio of female students entering engineering courses is generally low. One of the things we noticed when investigating the different courses, was a slightly lower relative completion rate for female students as compared to male students. Table 4 shows the female student ratio per course and overall for all students and only completing students. It clearly shows a higher ‘dropout’ of female students across all courses. Further analysis showed that age did not seem to influence this, and neither was the higher attrition rate caused by early dropout, but happened throughout the course. Also, we looked at self-reported belonging and perceived enjoyment of the course, and although female students did not report as much sense of belonging or enjoyment, this difference was not statistically significant.

Table 4. Male-female student ration start vs end of course (N = 65.596)

	ALL	AERO	CREDIT	NGI	SOLAR	WATER
Registered students (f)	19%	14%	21%	21%	15%	26%
Completing students (f)	15%	12%	17%	13%	12%	25%

When we looked more closely, we saw that female students, in all courses, are younger than male students. In line with that, we see far less female students in the older age groups, as can be seen in the stacked bar chart below.

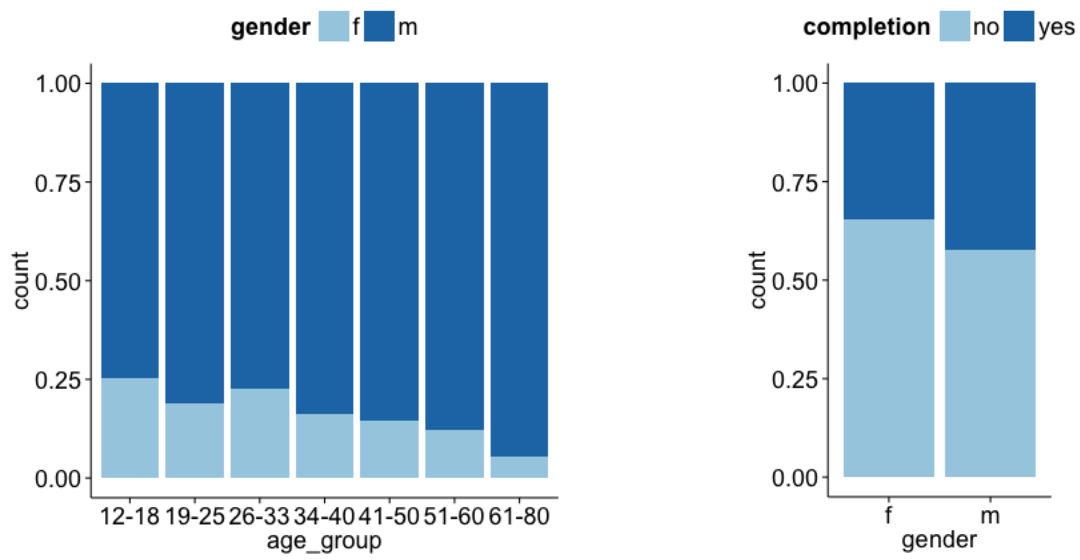

Fig. 3. Gender distribution across age groups & completion rate (grade > .01)

Likewise, we also see a lower performance (grade and completion) among female students. Excluding students who have not attempted any graded assessment (grade>.01), we do see a significant difference in average grade between male and female students: .36 vs .42, t(2753) = -7.3, p=.000. In addition, we see a lower completion rate, clearly shown in the second chart in figure 3.

The earlier hypothesized *'performance orientation'*can be seen in figure 4 as well: it can be hypothesized that male students are more motivated by obtaining a certificate of completion than female students, as we saw with younger students versus older students.

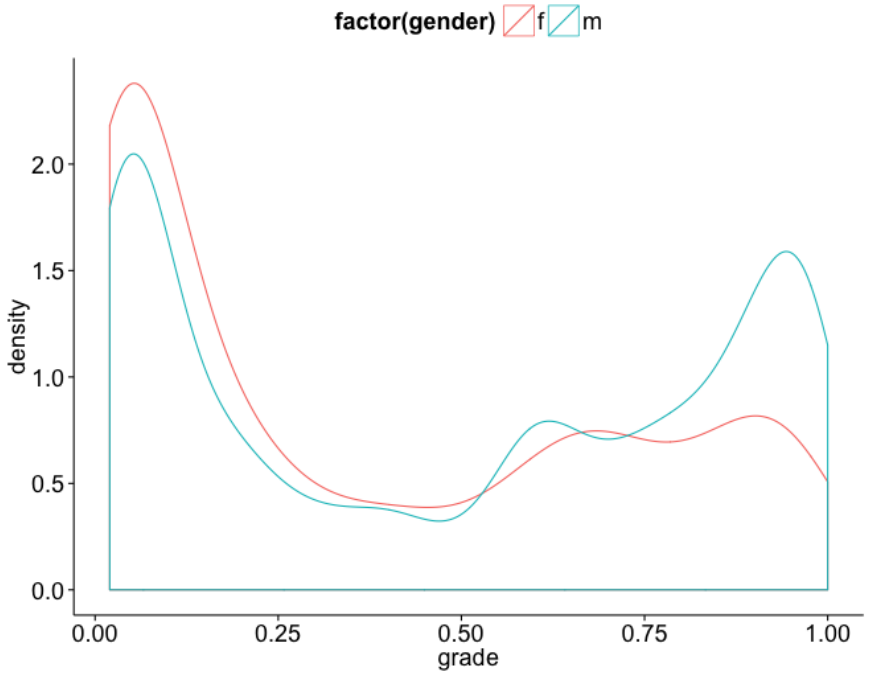

Fig. 4. Gender - grade density plot (filter: grade>.01)

In conclusion, we do see quite significant differences in performance and demographic factors between male and female students across all MOOCs. In addition, we see a low registration and participation rate of female students in technical MOOCs, which is a known issue. These and other matters related with gender and diversity are currently under investigation in other DelftX MOOCs.

5 CONCLUSIONS AND OUTLOOK

So far it seems that MOOCs, here exemplarily from TU Delft, reinforce the advantages of the 'haves' rather than educating the 'have-nots.' This general notion is confirmed by the TUD data, when looking at the characteristics of the completers. They are the better off participants who can profit more from the MOOC phenomenon, than anybody else.

It can be confirmed that the TUD shows a low registration and participation rate of female students in all engineering MOOCs. They are generally younger than male students and in line with that, there are far less female students in the older age groups. Females are more likely to drop out early on in the course, also their overall performance (grades) is lower than male students. Students without prior experience are more likely to disengage from the course early on.

We need to be careful in interpreting the outcomes. The term 'Massive' is also to interpret as the massive variety of the student population and of the kind of MOOCs, which makes it difficult to derive definitive conclusions despite the richness of the sources. What can be said is that the outcomes confirm the assumption that in engineering MOOCs females are less present even compared to the situation in regular education and that it is fair to say that this conclusion needs much more attention to conquer the situation that MOOCs promise to be open, but are in fact strengthening the underrepresentation of females in engineering education.

To draw first conclusions: There are quite significant differences in performance and demographic factors between male and female students across all courses where surveys were conducted. In addition, we see a low registration and participation rate of female students in technical MOOCs, which is a known issue. These and other matters related with gender and diversity will be investigated in upcoming MOOCs at DelftX. Gender and diversity relevant aspects of engineering education have to be proven for their use in MOOCs.

If following research approves that online learning manifests social stereotypes, engineering education research has to address this fact and has to work on didactic and methodologic solutions to really opening up online engineering education for all kind of students, related on gender, age, cultural, educational and professional backgrounds.

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