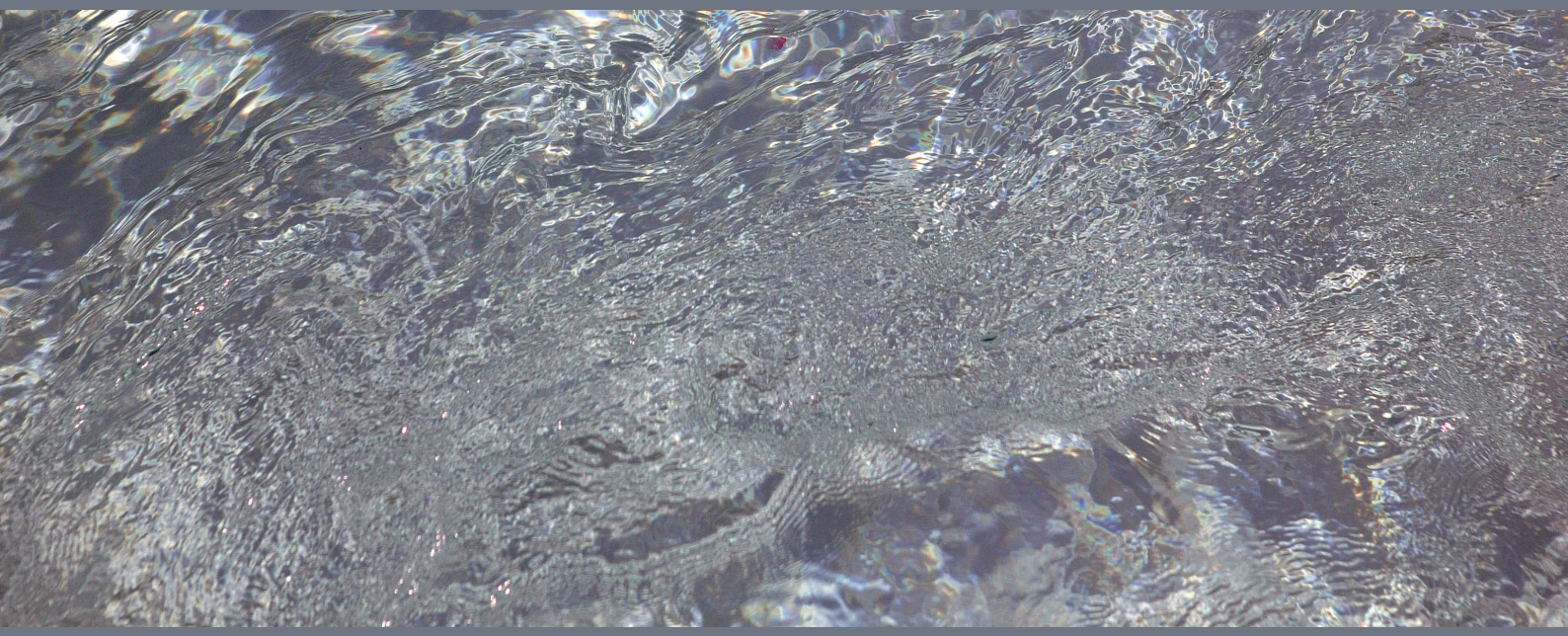
Delft University of Technology



TU Delft Online Learning Research Working Paper #2

DelftX MOOC Course Report CTB3365 Introduction to Water Treatment 2013

TU Delft

This report aims to provide an insight into the background, implementation and the results of the course. The information in the report and clean data accompanying it may be of relevance for MOOC developers, teachers and others in their aspiration to improve online education. A cross-course comparison of the first five DelftX MOOCs can be found in the 'Working Paper DelftX MOOCs, the first year (2013-2014)'.

Acknowledgements
We would like to thank the MOOC teachers, the developers, the New Media group, all the other stakeholders we interviewed and the DelftX team for their cooperation. In particular, we want to thank Christopher Davies (http://enipedia.tudelft.nl) for his help cleaning the raw data and providing us with useful code for analysis in R.

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Course report Water Treatment 2013

TU Delft Online Learning Research Working Paper #2

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Summary

Name course	CTB3365x Introduction to Water Treatment
Date	16th of September 2013 – 25th of November 2013
Faculty	Faculty of Civil Engineering
Teachers	Jules van Lier, Luuk Rietveld, Merle de Kreuk, Doris van Halem
# of students	29288 individuals enrolled, 545 completed
Level and prerequisite	The course is intended to be an introduction to water treatment technologies for everyone interested in sanitary engineering
Course resources	Video lectures, convergent quizzes, readings, video tutorials and video excursions
Suggested workload	10-12 hours a week
Course on edX	www.courses.edx.org/courses/DelftX/CTB3365x/2013_Fall/info

The course was designed as an introduction to water treatment systems on a bachelor's level with a focus on basic drinking water and wastewater treatment technologies for urban water services. It was structured in two long-lasting modules: drinking water and waste water. The course contained video lectures, convergent exercises, tests, and animations illustrating relevant engineering and physical phenomena. The assessment was focused on graded homework assignments and exams for corresponding modules. The materials were regularly updated. The forum showed heavy use at the start, but low participation in the remaining period.

Students were quite satisfied with the overall quality, the pace of the course and the edX platform and would recommend the course to others. They would have liked some more collaboration and worked examples, but in general this course worked out well inspiring 88% of the completers to continue studying in this field. The decrease in the number of participants especially after the first two weeks is a common trend and time seems to be the most important reason. Attention is being paid to this phenomenon, but the focus typically in this phase of development is on the course completers. The course attracted more female (25%) than common in MOOCs up till now. The majority of the participants had no background in the field and most joined the course to increase their knowledge. The teachers, developers were faced with a demanding schedule for production, but the overall experience was rather positive and seen as a next step to further integrate online possibilities in the campus programme.

1. Introduction

The course 'CTB3365 Introduction to Water Treatment' from the Faculty of Civil Engineering ran for 10 weeks from September to the beginning of December 2013. The course has a long tradition at the Delft University of Technology as a regular course with a good reputation worldwide. In total 29288 students enrolled and 545 completed the course, which is 2 %. The focus in the course was on urban water services, including basic drinking water and wastewater treatment technologies.

This report contains additional information about the background, the implementation of the course and the results with the purpose to add to the knowledge base of MOOC environments. The information has been collected from different sources like edX subscription data, edX student data, including the use of the forum. Using a pre- and a post-course survey made it possible to collect qualitative information on issues like expectations, motivation, prior knowledge level, and relevance and correlate the outcome with other data. The teachers and the development team were interviewed before and after the course to acquire more insight in their perceptions and experiences.

The main purpose of the analysis in this report is to provide useful information (and clean data) to the team of developers and teachers to improve the design and facilitation of subsequent online courses. The analysis was organized by the O2E research team (Open and Online Education) from the TU Delft in close collaboration with researchers from the University of Southern Australia.

2. Course Design and Pedagogy

2.1 Design, Learning Resources and Workload

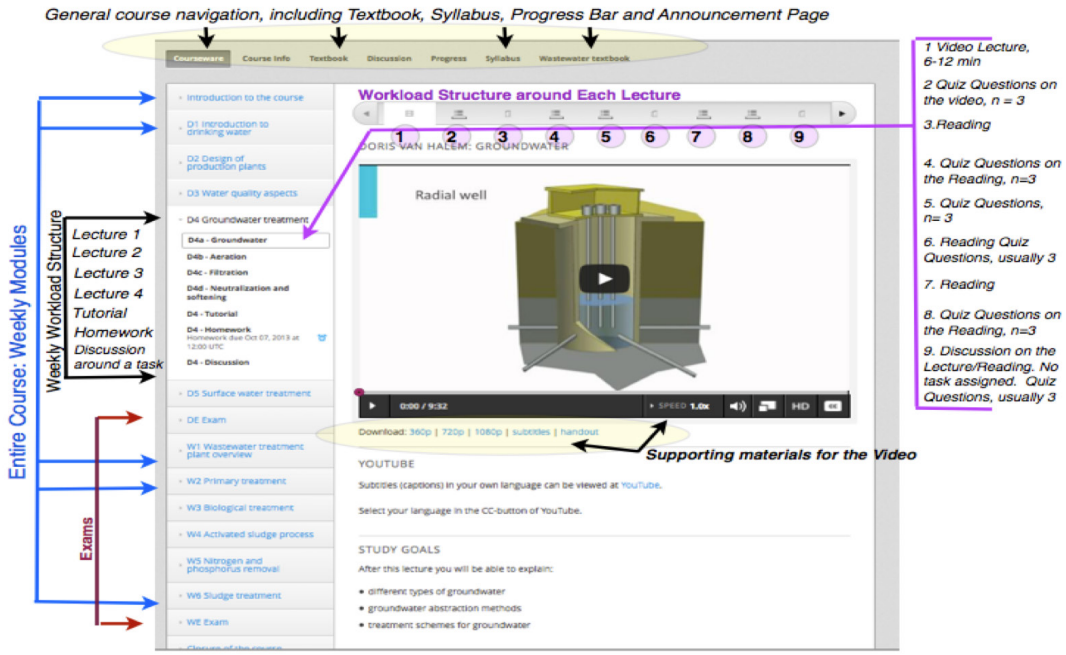


Image 1. Screenshot of the Structure of WaterX

The course was designed as introduction to water treatment systems, and advertised as a bachelor-level course without prerequisites. It was structured as two long-lasting modules: drinking water and waste water; and taught by four instructors.

The main goal was to learn about urban water services, focusing on basic drinking water and wastewater treatment technologies. These two treatment chains were described as well as the physical, chemical and biological processes involved. The emphasis was on water quality and the functionality of each unit process within the treatment chain. After the course students are supposed to be able to recognize the process units, describe their function and make simple design calculations on water treatment plants (drinking and waste water). As such the course clarified the role of treatment technologies in providing adequate water supply and effective sanitation as essential for human society and the safeguarding of public and environmental health.

Course assessment put heavy weight (80%) on exams for correspondent modules. The passing grade for this course was 60%. Besides, two exams, the course had 10 graded homework assignments, and 150+ ungraded quizzes for comprehension check. Generally, the estimated workload for WaterX, was at 10-12 hours a week. 16% of the completing students indicated that they indeed have worked 10-12 hours a week. Based on the responses on the post survey we found that 25% of the students worked between 5 and 10 hours per week, while a low 5% worked less than 2-4 hours, and 23% worked more than 5-8 hours (figure 1).

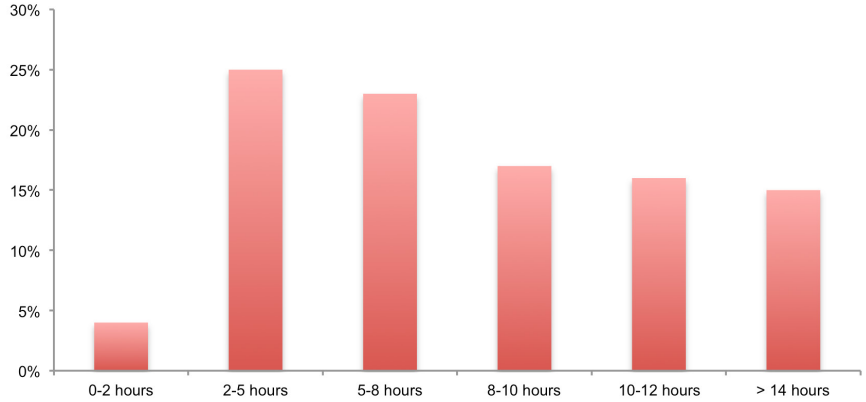


Figure 1. Overview of estimated workload

More than half of the respondents worked less than the estimated workload. When asked whether the amount of work that was required was too little, too much or just right, 64% found the amount of work "just right", 36% found that the amount of work was "too much". In the Water Treatment course 30% of the completing students found the course to be "too difficult", which may relate with the relatively higher (perceived) workload for Water Treatment students. 97% of the students found the pace of the course to be "just right". 67% of the students found the duration of the course to be "just right", while 28% found it too short.

Course used video lectures, convergent exercises, tests, and animations illustrating relevant engineering and physical phenomena. It was regularly updated with the news and announcements. Forum was moderated heavily in the first weeks, with monitoring but low participation, in the following weeks. Weekly group-level feedback videos were issued. Overall, the balance of the learning resources for the course is visualized in figure 2.

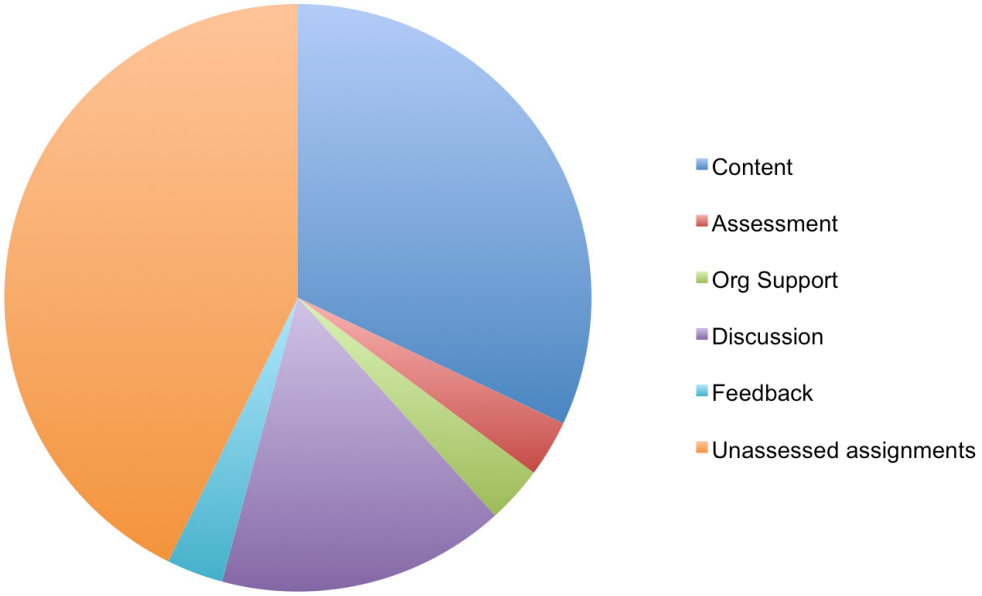


Figure 2. Balance of the Learning Resources in WaterX

2.2 Student Feedback on the Course

The average rate for the quality of WaterX is 4.35 out of 5. The average rate for the teaching is 4.20 out of 5. The lowest score is for student to student interaction on the forum, which can be explained by the fact that the forum was not used by the course team for the course. Similarly, the feedback received a relatively low score: there were no feedback videos or interaction between the course team and students on the forum. The chart below shows the rates of the other elements of the course:

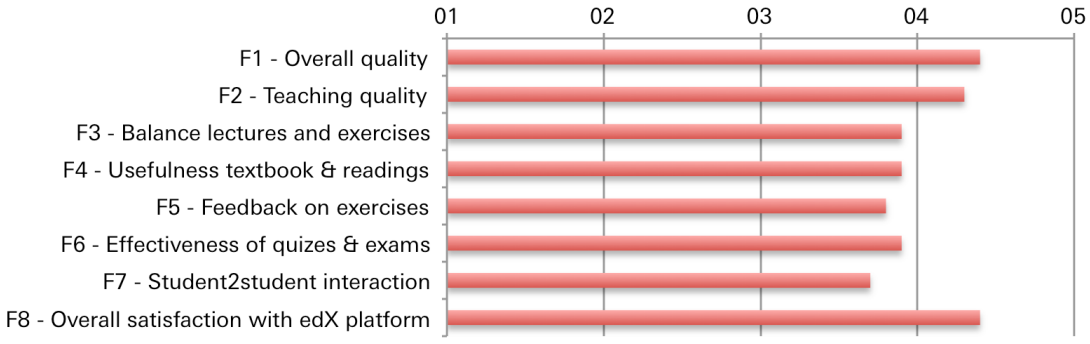


Figure 3. Satifaction and Feedback on Course

The illustration below shows how students perceived the clarity of goals of the course, the quality of the video lectures, and issues related with the questions, exercises, and exams. It seems that questions were not clearly formulated, and that the number of attempts for questions in exercises was not considered adequate.

Figure 5 addresses the most encountered technical issues named by the students. It shows that a relatively high percentage of students encountered technical issues, most importantly a slow internet connection.

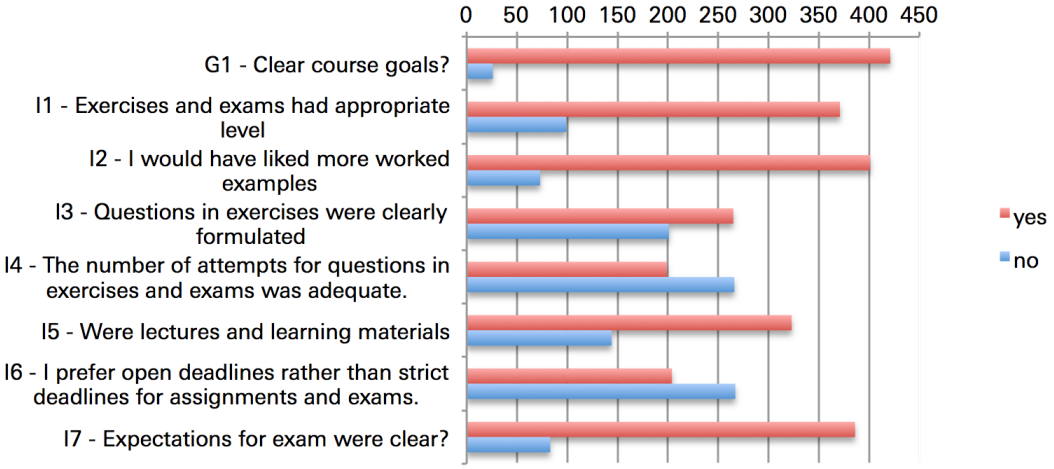


Figure 4. More feedback students (course, teaching, materials

Although this is something that should be avoided in the future, it does show that the course has attracted interest in regions with low Internet bandwidth.

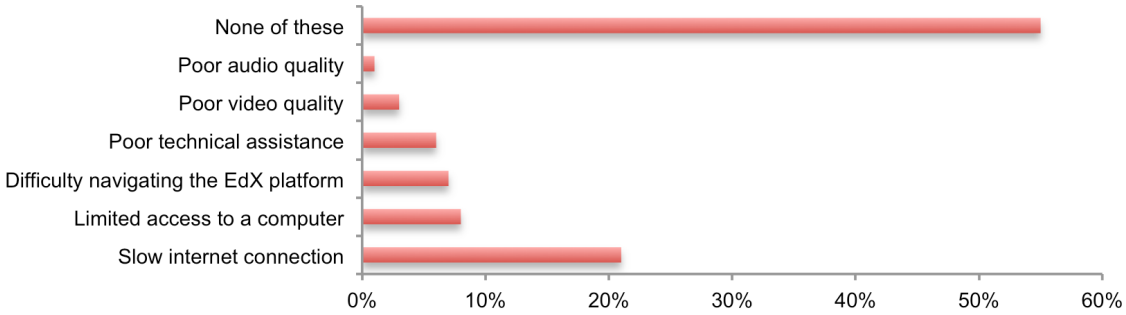


Figure 5. Commonly reported problems

3. Student-related Demographics

3.1 Registered Students

65% of the enrolled students were male, 25% - female, which is generally a very high number of the female participants in the first generation of DelftX courses. Over 50% of the enrolled were 19-30 years old, with another 20% being 26-30 years old. Around 40% of the registered had Bachelor's level education, and around 24% had Master's degrees at the time of enrollment. Over 60% of the registrants indicated that they had no background in the course topic. For more specific information, please see Appendix 1. Here, we see a similar pattern as in the Solar Energy MOOC, with a lower average final grade for students without prior experience (.16) compared to those with experience (.25). If you look at students with a grade higher than 10%, we see a much smaller mean difference (.50 vs .53), which also has a higher p value (.04). If we take the threshold even one level higher (grade students has to be above 20%), we see a further reduction of mean grade difference (.57 vs .59) which is also not statistically different. This shows, as in the Solar Energy MOOC, that students with little to no experience are less likely to start the course or continue with it after a first try. Why this is so, and if it can be improved is not clear, but it is worth looking into. (table1)

Category	N (grade>0)	Mean grade	N grade>.1	Mean grade	N grade>.2	Mean grade
No prior experience	1071	.16	307	0.50	252	0.57
With experience	917	.25	395	0.53	341	0.59

Table 1. Prior experience and grades

The majority of students registered identified themselves as from either the US or India. The number of Asian students was relatively low. Table 1 shows the break down for top 20 countries of origin. Four questions were asked to identify students' cultural background in a more elaborate manner: "Where are you from?" (Column Total), "Where were you born?" (Column Born), "Where do you live?" (Column Lives in), and "Which country did you get your latest degree from?" (Column Was educated). For example, although a total of 23% of students identify themselves with the US; only 21% are American-born, while 24% are American-educated, and 26% are residing in the US. Such slight variation points towards a more culturally diverse "American" students group, which also includes US-educated immigrants, and non-US educated immigrants. Several other countries have the same dynamics. Although the variation is small, from our further research we learnt that students with Mixed cultural backgrounds, e.g. born in one country, studied in another, and living in the third,

	Born	Lives in	Was educated
United States	23%	26%	24%
India	19%	17%	17%
Spain	9%	8%	9%
Netherlands	4%	5%	5%
Brazil	5%	5%	5%
Colombia	5%	4%	5%
Mexico	4%	4%	4%
United Kingdom	3%	4%	6%
Pakistan	3%	2%	3%
Canada	3%	4%	3%
Nigeria	5%	4%	4%
Greece	3%	3%	3%
Philippines	4%	3%	3%
Australia	2%	3%	2%
Egypt	2%	2%	2%
Germany	1%	2%	2%
France	1%	1%	2%
Portugal	2%	2%	2%
Italy	1%	1%	1%
Chile	1%	1%	1%

Table 2. Top-20 countries of origin, currently living, and received education

make up about a quarter of completing students, and have complex learning and interaction preferences. Besides these minor differences, it can be generalized that the majority of registrants came from South East Asia, followed by English-speaking countries, Latin America and Latin Europe.

In the pre-course questionnaire, the students indicated a variety of reasons for enrolling in the course (Figure 6). The most common reasons were 'To increase my knowledge and skills', 'To challenge myself', 'Because I find the topic interesting and fun' and 'To earn a certificate'. When we look at the goals of the students regarding the completion of the course, most of them were initially 'committed to do all the work and earn a certificate', however not everybody accomplished this goal. The reasons for participating did not differ across the courses, the reasons are shown in the chart below.

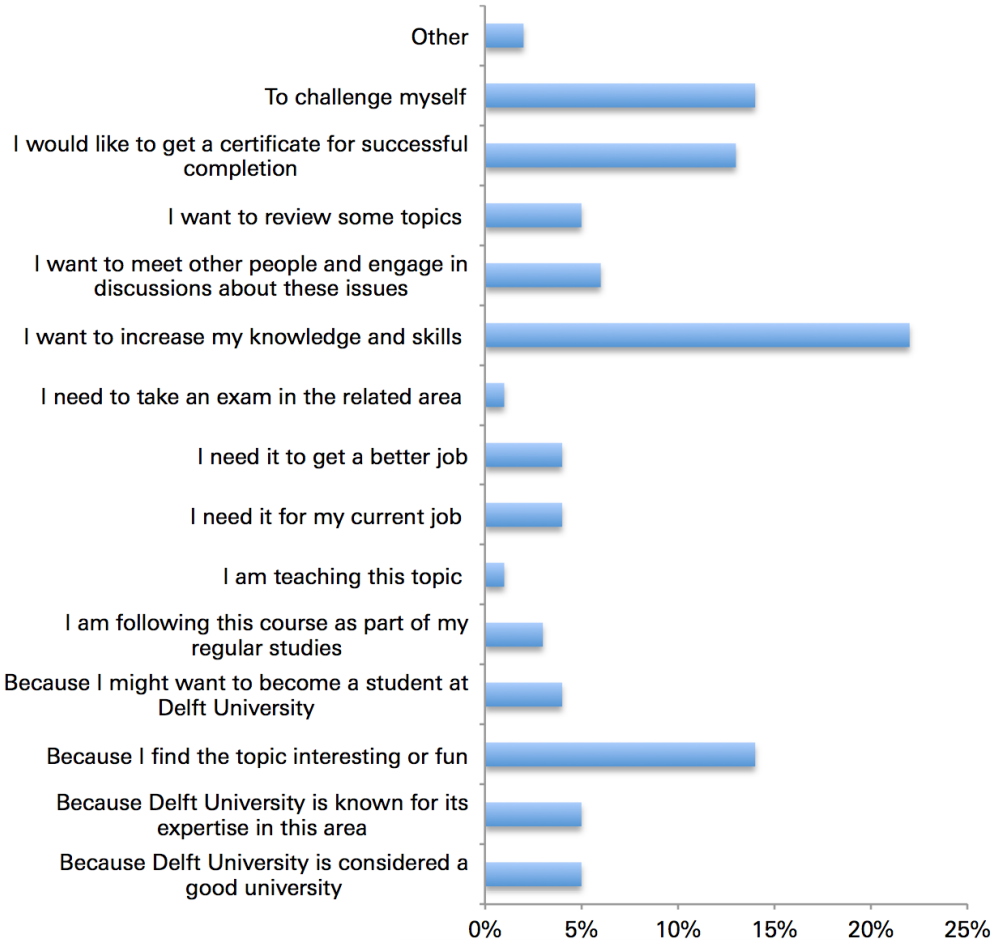


Figure 6. Reasons for taking this course

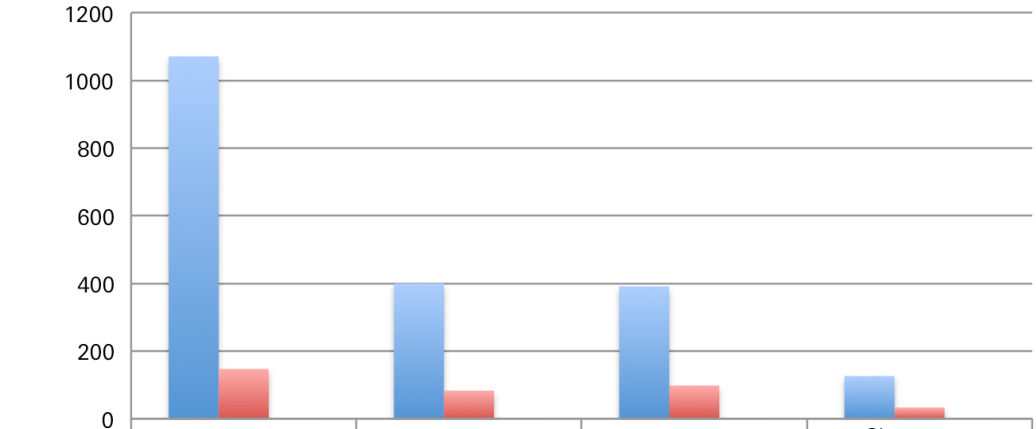
Most students, ound out about the course through the edX website. It seems that many students already have experience with edX, or at least knew the website and browsed to find a course (figure 7).

Figure 7. How did you find out about the course?

3.2 Students Receiving Certificate of Completion

65% of completing students who received a passing grade of 60% in the course (N=410) were male, 29% - female, information about the others was not available. Completers in this course were generally older than observed in other courses, with almost 30% being 31-29 years old, 23% being 26-30 years old, and 21% being 19-26 years old. The majority of students who received certificate of completion came from South-East Asian countries, such as India. The second largest group of completers is from Latin American countries, followed by Latin Europeans and participants from Eastern European countries. In this course, an overwhelming majority of completing students (80%) had bachelor or master level education prior to the enrollment of the course.
For more details on the demographics, please see Appendix 1.

In line with the earlier statistics about experience and completion, the figure below shows the 'passing rate' per category. It shows a correlation between experience and grade. Such demographics illustrate that teachers may have overestimated the difficulty of the course for the intended broad audience.
In pre-course questionnaire, we asked the learners what they believed was the most important quality for



	No prior experience	Class that would precede course	Same level	Class more advanced than course
Start	1071	400	391	126
Complete	147	83	98	33
Pass rate	0.14	0.21	0.25	0.26

Figure 8. Background in the topic

completing the MOOC, demanding that they give priority to either "knowledge" or "effort" put into learning. This stems from research into student psychology and the attitude they have towards intelligence. It has been shown that students who perceive effort as more important than intelligence perform better. However, we do not see any difference in the grades between these two groups. Most students consider effort a more important reason for course completion than being knowledgeable about the topic. Further examination of prior backgrounds of the completing groups of learners, who believe in knowledge as key to success, may shed some light into their persistence patterns.

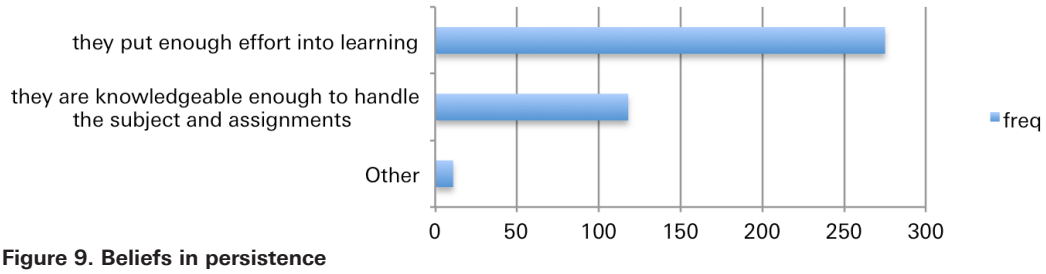


Figure 9. Beliefs in persistence

4. Retention and Formal Performance

16% of students who engaged in the first homework assignment in WaterX received the passing grade of 60%. The average grade in the course is 72% (for details, see Appendix 2). From figure 10, it could be seen that most drop-out occurred between the first and the second homework, but a large number of participants still attempted the first exam, which all in all indicates the interest in the course, but also points towards it being possible of challenging content. The drop out rate after the first exam, almost leveled out.

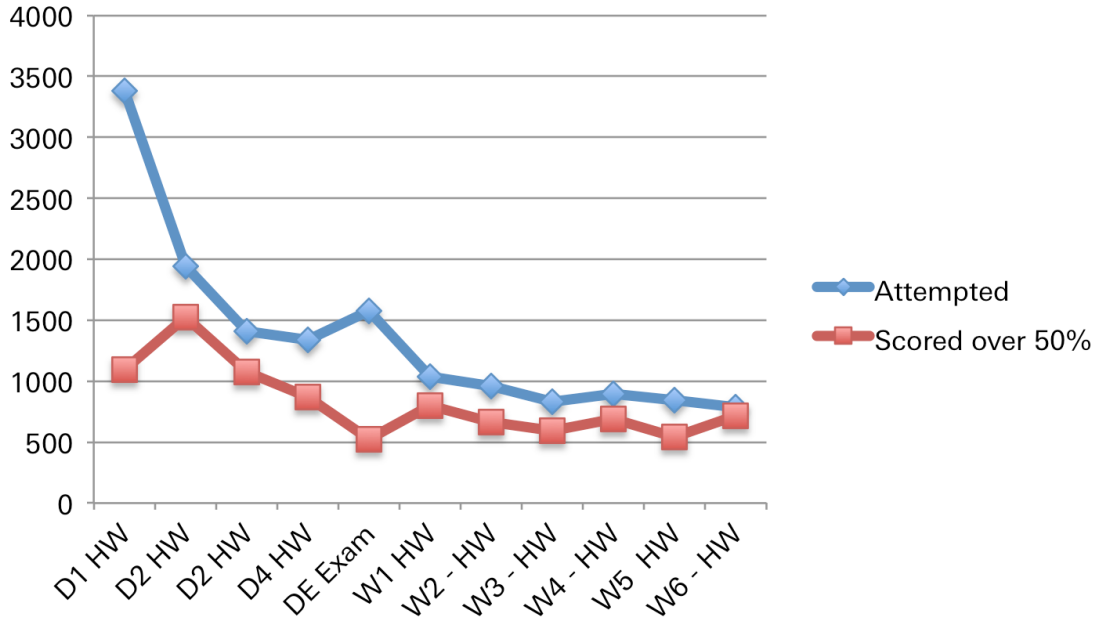


Figure 10. Formal retention in the course.

We asked the students who did not complete the course how they would describe their participation and why they didn't complete the course. 88 participants have submitted their answers. The chart below provides an overview the level of the level of participation of students who identify themselves as being inactive. The most common 'inactive process' was to follow the course whenever the student had time. The chart that follows shows the reasons for inactivity.

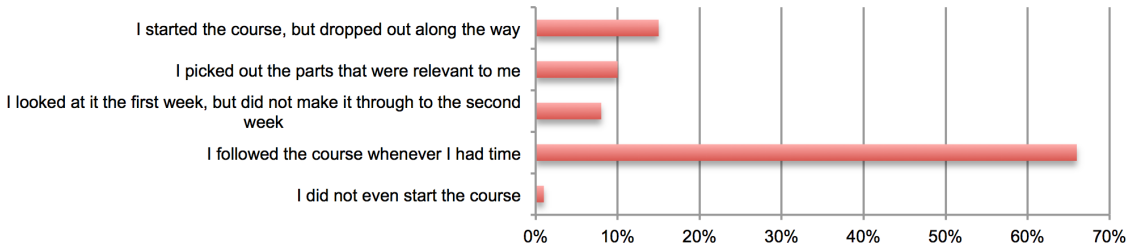


Figure 11. How would you describe your participation?

By far, the most important reason for inactivity was not having sufficient time to follow the course and do the assignments. Technical and work-related issues are other significant reasons for inactivity. No student indicated the low quality of the course as most important reason for inactivity (figure 12).

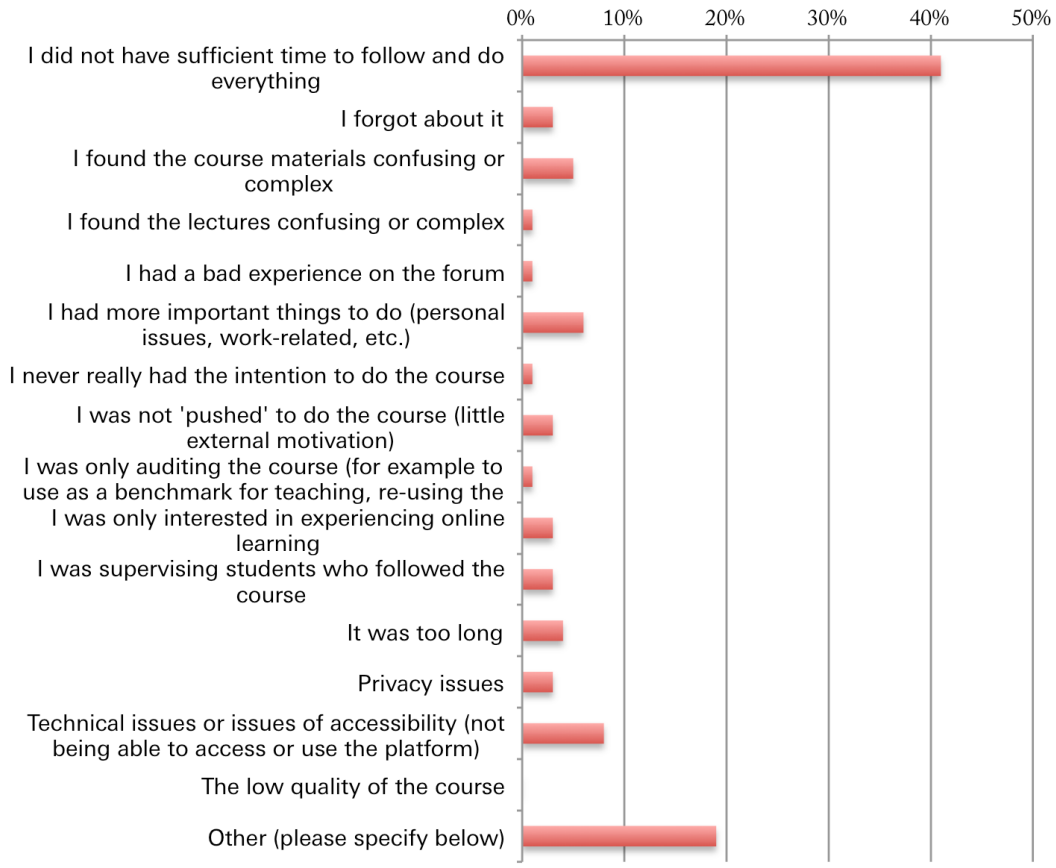


Figure 12. Reasons for becoming less- or inactive

5. Course Forum and Student Interaction

5.1 Student Reported Interactions

The charts below show the answers reported by students in a post-course questionnaire (N= 487), in relation to their peer-to-peer and peer-to-teacher interactions within the course. An analysis of variance points out that students who interacted with "Nobody" have a statistically lower grade (.60, n=118) than those who did interact with someone else (.65, n=430) – with p-value of 0.03. This also holds if you take just the students who passed the course (.70 vs .73). Even though the differences are quite small, they may have meaning, as we are also seeing a correlation between forum posts and grade, even above a certain threshold. Further exploration of the actual interaction students have during a course can help us understand the value of interaction and collaboration during online courses more deeply.

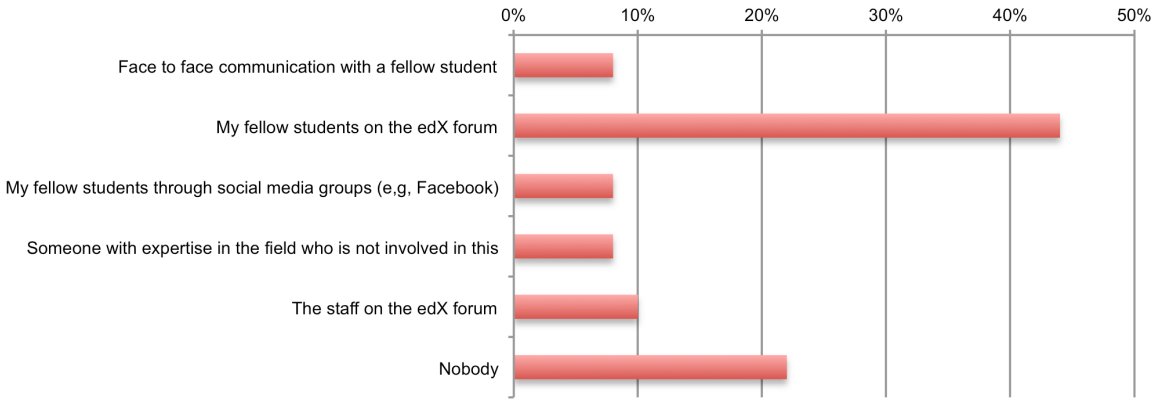


Figure 13. With whom did you interact?

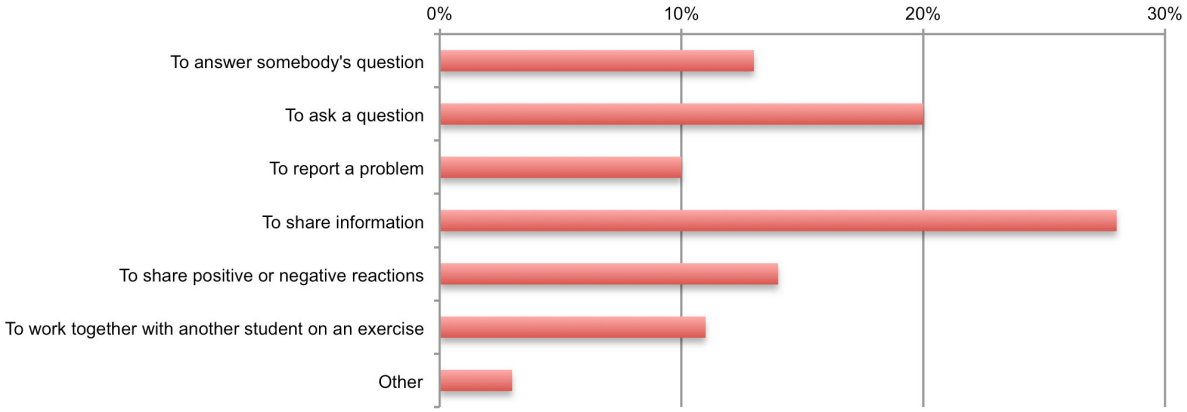


Figure 14. What was the reason to interact with other students?

5.2 Course Completion and Use of the edX Forum

In order to show the activity on the forum, all the completing users were classified into several groups: passive, (i.e. those who made 0-3 comments, e.g. "My name is …", one one-threaded post about an opinion, and "Thank you for this wonderful class"); inactive (4-6 posts); moderately active (7-14 posts), active (15-29 posts), very active (30-49 posts) and super-posters (50-700 posts). Table 2 and Table 3 present more detailed information about the volume of social activity shown by the competing students.

Table 3. Number of posts and completion

	Water
Total # of posts produced by all completers	4819
Max # of posts per person	239
% of completers who made "0" posts	22%

Table 4. Frequency of posts per course

	Water, %
Super posters (50 - 700 posts per person)	2,38
Very active (30-49 posts per person)	3,48
Active (15-29 posts per person)	9,78
Moderately active (7-14 posts per person)	17,58
Inactive (4-6 posts per person)	14,29
Passive (0-3 posts per person)	52,20

Generally, the forum in Water Treatment is small – both in relation to classes of bigger size (3 or four times smaller), and classes of the same size (about one quarter smaller). However, as compared to other forums one can say that in Water Treatment, overall more students participated in social learning and posted, as compared to other courses. Non-super posters produced more than half of the forum content. Table 5 below shows the distribution of activity among the group of completing students, as well as what is the ratio of posts they produced. In Solar, we see two disparate groups of "very active" and "active", and a very large group (and a long tail) of inactive.

Table 5. Course Completion and Participation on the edX forum

Course	Water Treatment	
	% of completers	*% comments they made*
Inactive (0-3 posts)	52,20	5,50
Active (3-50 posts)	45,05	64,37
Very active (50-700 posts)	2,38	29,78

5.3 "Vocal" MOOC Completers

We have analyzed basic demographic factors of 43 completing participants who produced half of all the posts made by the group of completing students. This was done to gain a general idea as to what kind of learners are vocal on the forum of this course. The composition of the group corresponded with the gender representation in the entire course, with 1/3 of participants being women, which is generally a high number of DelftX courses. All ages were represented, again, corresponding to the general course composition, with both younger and older learners being active.

Culturally, the majority of completing vocal participants were from English-speaking countries, followed by Latin America and Latin Europe. These three cultural groups are typically found to be dominant on edX forums, while South East Asian learners, who are a leading cultural group among completers, are under- represented on the forums (only

10%). Middle Eastern and African cultures are under-represented on the forum. We can see that no students from Confucian Asia have been a part of the "vocal" edX community.
Over 50% of the completing group students actively involved in the forum had bachelor's level education, over 30% had master's level education, and some 15% had high school level education. It should be noted that some of the older learners successfully competing and actively participating in the course had high school level education from developed countries.

5.4 Online Study Groups – Alternative Communities of Learning

While the MOOCs were running, it was noticed that the students organized several online communities around DelftX courses on Facebook. Students advertised their Facebook group and invited others to join. Our curiosity to understand what the learners were missing from their edX experience motivated our choice of analysis of the Water Treatment Facebook group that was organized around homework preparation.

The group had a total of 73 members, half of the members participated through lurking, while the other half, i.e. 43 members was active. One third of the active members completed the course. There were three more course completers who lurked but did not post. Two group members were among top ten students of the entire Water treatment course.

Many of the Facebook group members could be considered high achievers of the course. The two networks that represent Facebook group activity (Figure 15) are constructed to represent a student (a node) talking to the other student (another node) through a link between them. The strength of the link represents the number of interactions they had with each other. The color of the node represents cultural cluster, e.g. violet – Africa, purple – South East Asia, blue – Middle East, and green – Latin America and Latin Europe; the size of the node in Figure 15a represents the number of interactions made by the person; the size of the node in Figure 15b represents the grade received by the same students.

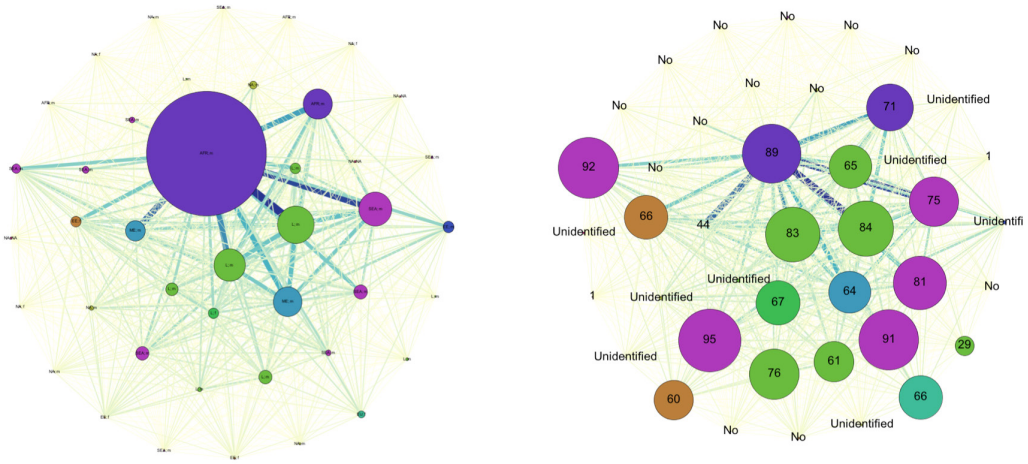


Figure 15. Network of Facebook group users. Network on the left: node size represents number of posts made by the learner.

One of the first things that stand out in Figure 15a is the number of purple nodes, students from South East Asia, who are the dominant cultural group in the overall Water Treatment course. They are under-represented group on edX forum. On the contrary, students from English-speaking countries that dominated edX Water Treatment forum are not represented in this Facebook group at all. It is also noteworthy the South East Asian students with their high performance on the right-side network, show relatively less participation on the left. However, their voices are more represented within this group, than they are on the edX forum of this course.

Further analysis revealed that half of the Facebook group members indicated having no prior background in the subject on the pre-course questionnaires. This may point towards the group being "weaker" in terms of preparation to tackle the subject, and needing more support in learning, in particular in overcoming the initial obstacles, as we hypothesized before. Considering only 28% of all Water Treatment course completers had no prior background, we know that it was not easy for "less prepared" students to survive the course. Having 50% of completers on Facebook without prior background shows that they may have found here the support they needed.

Summing up, we consider it a good example of a case where motivated students self-organized in a study group. The group was demographically younger (as opposed to a more older forum dominated group), more male dominated, at least in the discussions, and having more South East Asian and Middle Eastern students, than the vocal edX Water Treatment group. Finally, Facebook group members had overall less background in the subject, and also (as post-questionnaire shows) found the workload to be "too much" (Figure 14b).

6. Looking back

A post-course survey for students and a post-interview with the teachers and developers of the course allowed us to collect some qualitative information on the experiences of the participants. The pre-survey had 6194 respondents; the post-survey had 487 respondents while 545 students received a certificate, so this could mean a 78% response assuming that only the completers filled out the survey.

From a research perspective it was interesting to see what these students were doing and what their perception was looking back after successfully finishing the course. Therefor the post-survey zoomed in on issues like confidence in handling the course, how determined they were to finish the course, the use of the online forum, social interaction, the relevance of the course, the challenges, their expectations and experiences, course quality and the question if the course inspired them to continue learning?

Overall the MOOC was highly appreciated by the participants. More than 95% would recommend the course to others and take another course given by the same team. More than 95% indicate that their appreciation for the TUD has risen. The courses inspired more than 80% to continue studying in this field and more than 50% was considering applying for an online graduate course.

More than 50% of the participants in the WaterX course had a professional occupation related to the course and 40% of the employed people indicated that they were allowed to work on the course during working hours. The most common reasons to take the course were: 'To increase my knowledge and skills', 'To challenge myself', 'Because I find the topic interesting and fun' and 'To earn a certificate'. Most students (70%) found the level of the course just right, the rest found it too high. They considered the pace of the course and the duration just right.

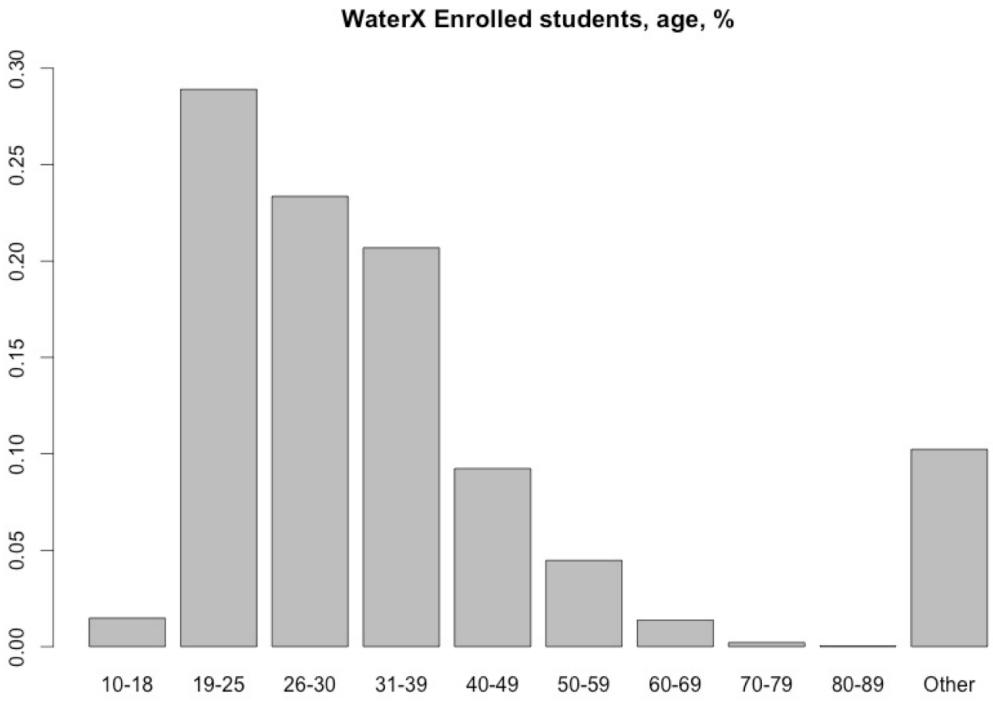
Teachers and developers

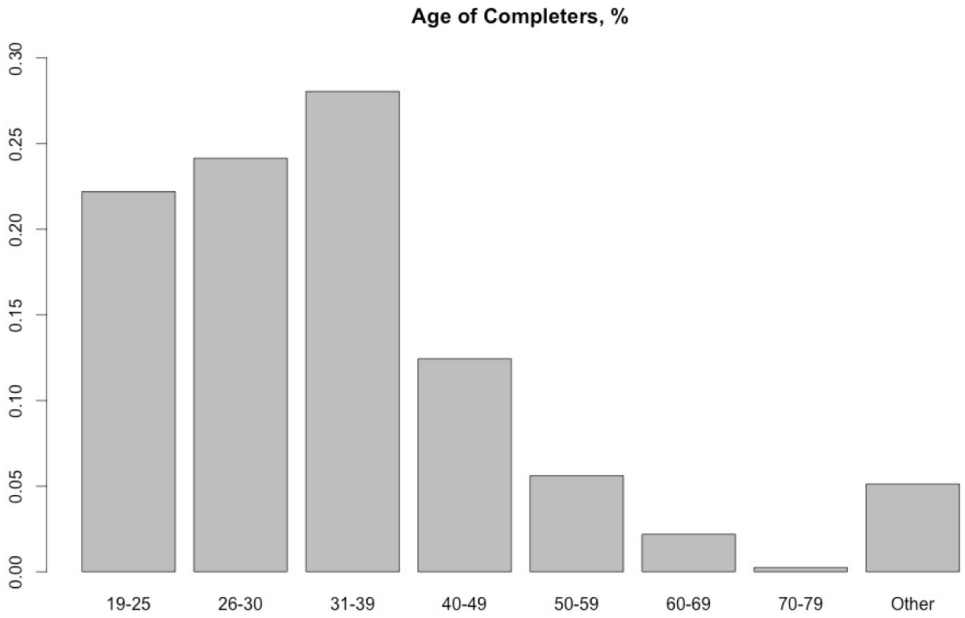
The main goal of the developers of WaterX was to create a marketing tool and at the same time develop a test case for the online master programs in Water Treatment. There was no MOOC design process available at the start which made it initially impossible to make a realistic time planning. So the biggest challenge for the developers was the time pressure due to uncertainties in the coordination, production time, agendas and other organizational practices. There was a clear wish for a MOOC design guide with a stepwise guideline of tasks, an overview of functions and a time planning for making a MOOC.

For most people involved online learning was a rather new activity and a MOOC adds to the complexity of this process. The time pressure is obviously related to the many new things that had to be developed in a short period of time. This process of co-creation is highly demanding, but rather normal for such a first time product. Teachers, developers and students though showed a rather good spirit, being very enthusiastic about this endeavor.

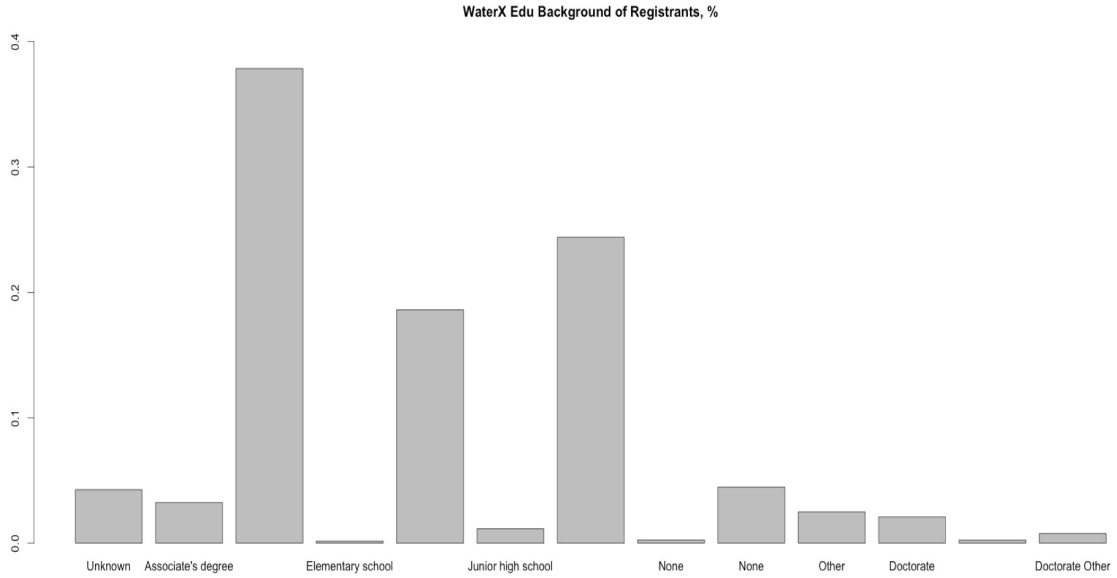
Appendix 1. Learner Demographics

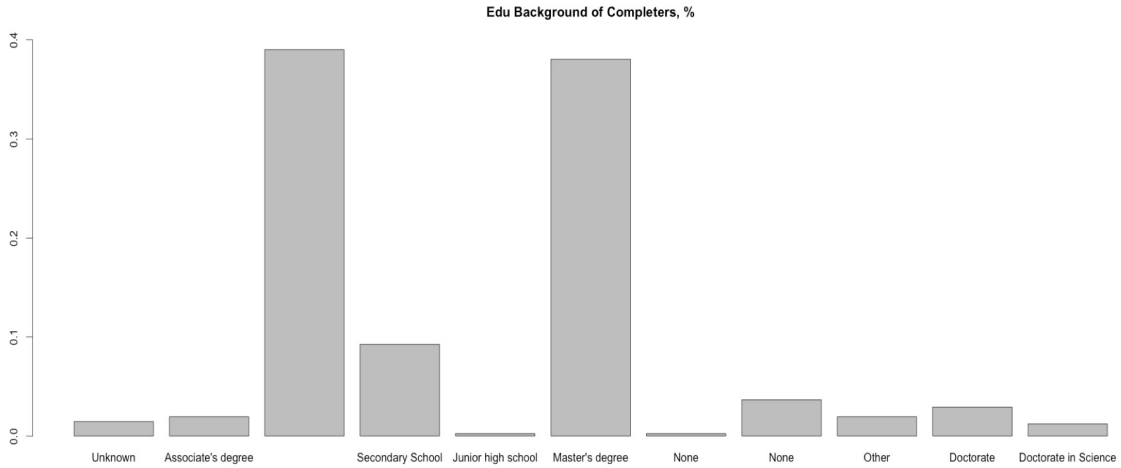
A) Age



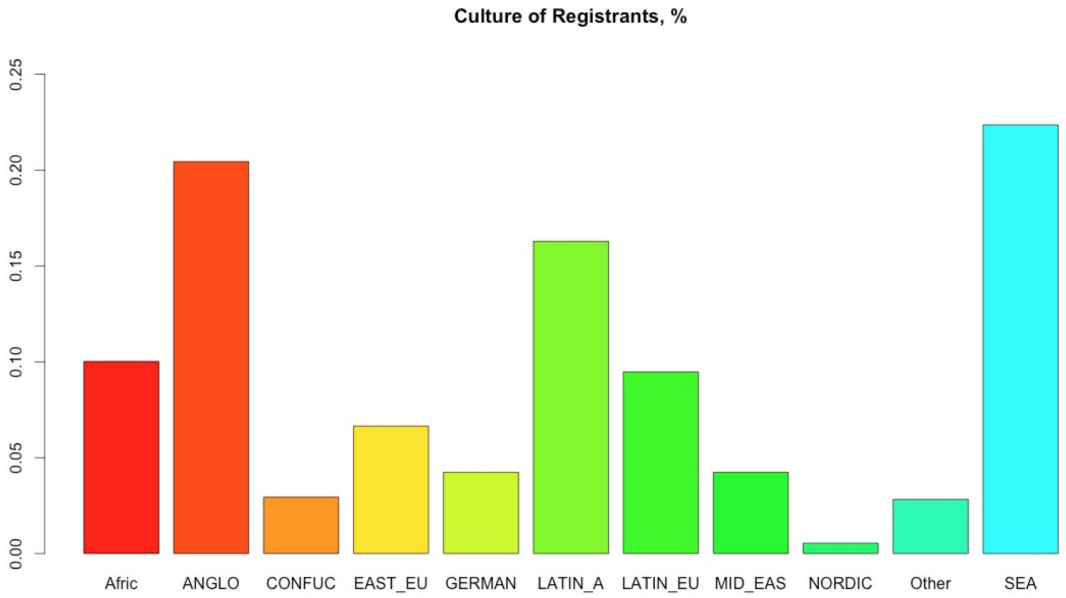


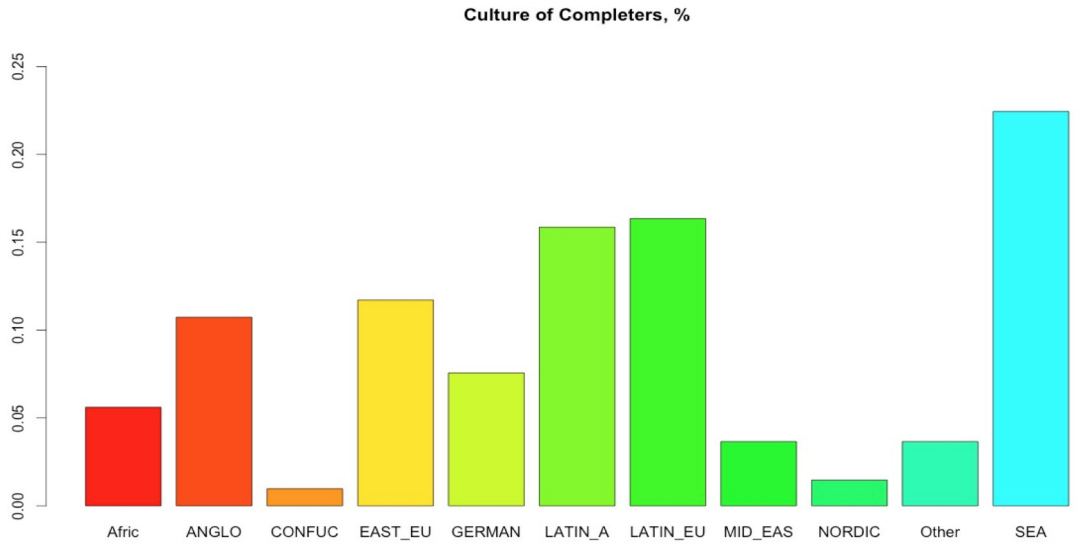
B) Educational background





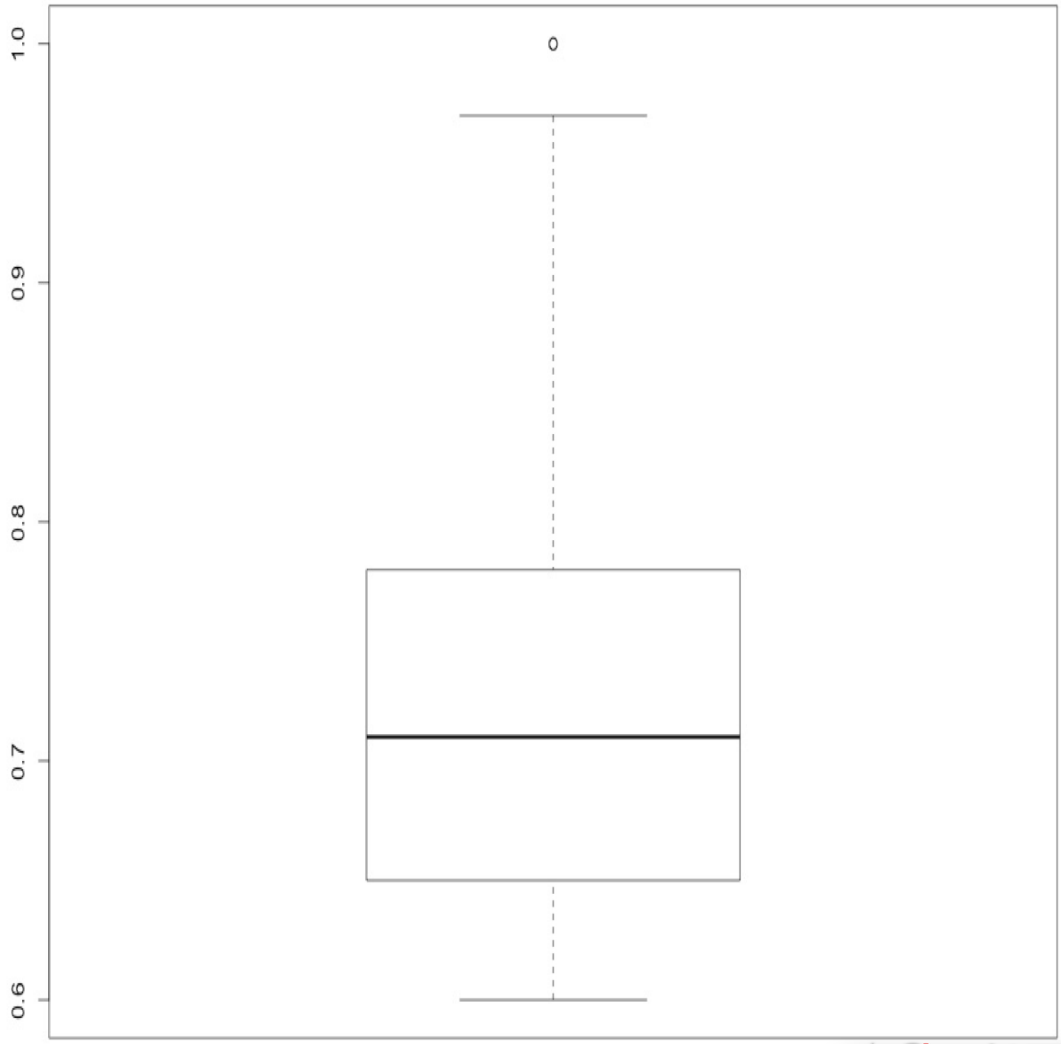
C) Cultural Background





Appendix 2. Grade Distribution

The boxplot of grades of the completing students below shows that 75% of the students received a grade lower than 0,8.



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