# Performance of Men and Women in Graded Team Assignments in MOOCs

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***Abstract*—This paper analyzes the implications of gender when evaluating team assignments in Massive Open Online Courses (MOOCs). It contributes to the line of research focusing on group work in MOOCs from a gender perspective when peer grading is carried out. In turn, it informs MOOC design. The results are based on a study of 6,000+ participants of a set of IT, business, and Design Thinking MOOCs to determine success in gender homogenous and heterogeneous virtual team tasks. The study uses observational data to track individual performance, based on gender, in online courses. Even though men were overrepresented, individual female performance in team assignments is shown to be significantly better than male performance. The results speak for successful teamwork in online courses on the one hand and open up further opportunities for good performance of women in STEM disciplines on the other hand.**

***Keywords—MOOC; Online Learning; Distance Learning; Virtual teamwork; Performance; Gender, STEM, Study***

## I INTRODUCTION

The "ability to work in teams is an important skill in today's work environments […] as a way to tackle the challenges of the future" [1]. Massive Open Online Courses (MOOCs) are becoming prevalent in Human Resource (HR) development–including onboarding, customer training [1, 2, 3, 4, 5], and labor market-relevant skill development [6]. While there have been some studies that consider the relationship between gender diversity in teams and research performance [e.g. 7], women are still in the minority in science, technology, engineering and mathematics (STEM) [8] fields and, to the best of the authors' knowledge, there are no specific studies available on male and female performance in graded team assignments in MOOCs. Therefore, this paper sets out to take a closer look at teams with different gender constellations. (1) Gender heterogeneous teams with females making up at least half of the members, (2) teams with less than half but at least two female members (22-43% women), and (3) teams where one female belonged to an otherwise completely male team (11-33% women) in comparison to gender homogenous teams (all-male or all-female). We show the similarities and differences concerning the success and performance (if any) in virtual teamwork according to gender. We will further discuss which opportunities and challenges digitally based work in gender homogenous as well as heterogeneous teams implies for team assignments in MOOCs to predict and prevent dropouts. Therefore, we analyzed the participants' performance data in several teams in a variety of courses. The socio-demographic and geographical background of the team task participants more or less mirrors the total course population; mostly high performing participants are registering for the team tasks [1].

## II RESEARCH QUESTION AND HYPOTHESIS

This paper investigates the questions of whether gender heterogeneous teams perform better than gender homogenous teams and if there are similarities or differences in the unique participant's performance in virtual team-based assignments by gender. These questions have been on our mind since we started offering team assignments on our MOOC platform in 2016. According to our experiences and previous research, we assume that heterogeneously composed teams perform better than homogenous teams. There is a lack of research on team and individual performance in team assignments in MOOCs by gender. Therefore, we analyzed the learning data of MOOCs, in which we conducted graded team assignments, and accumulated the results of a survey conducted among 309 registered users of these team tasks.

## III THEORETICAL BACKGROUND, TOOLSET AND RELATED WORK

As the social constructivist learning theory defines learning as a social activity of interaction between humans, especially in working on a joint task, collaborative learning is an important element in the field of digitally supported learning. It happens whenever we interact with other humans and works best when we engage in a common task [9, 10]. Collaborative learning [1, 11, 12, 13, 14, 15, 16] among the course participants has been an important element of our MOOC platform in terms of a worldwide social learning network since we started our first MOOC in 2012. Therefore, besides learning videos and quizzes we provide different types of collaboration. This ranges from low-profile, large-scale collaboration [16], such as discussions about certain aspects of the learning content in the general course forum with all participants of the course, to the provision of learning rooms for loosely paired groups of participants. Finally, in 2016 we conducted the first course containing a graded team assignment on our platform [17]. Co-learning experiences were intensified by enabling increased collaborative team orientation and thereby making further use of the WeQ, "a significant orientation to the common good in their goals and a major collaborative team orientation in their work attitude" [18].

### A. *Team-based Assignments*

"Peer Assessment" is a process whereby learners evaluate the work of their peers and provide feedback to improve their own understanding of the course material. Since 2016, we also allow this type of assessment for teams. In the context of setting up group activities, one major challenge of MOOCs is how to manage learners' lack of commitment and to keep dropout rates down [1]. We tried to address these problematic areas by developing a web application for team-based assignments that allows learners to proactively indicate their interest in participating in a group activity and their availability. Teams are based on this information as well as the time zone in which the participant prefers to work and a variable set of more parameters, such as the participant's gender, age, professional background, area of expertise, commitment in terms of time, preferred language, and location to allow face-to-face meetings. Educators can activate parameters of this variable set which are best suited to their ideas on matching teams. In general, the strategy is to build as many teams as possible with a good heterogeneous distribution of a certain parameter instead of few teams with a perfect heterogeneous distribution and the rest getting more and more homogeneous [14]. The teaching team can correct the results of the automatic clustering manually. [14].

In our team-based assignments, learners usually work in virtual teams on a common task in the course context (e.g. a small project, for two to six weeks). Depending on the particular course, the type and relevance of the peer assessment can be very different. In some MOOCs (e.g. *javawork2017* and the Design Thinking courses), the graded team assignments were obligatory to pass the course. By contrast, the team task of the *bizmooc2018* was structured in a separate track. Then again, in the courses *javaeinstieg2017* and *java1*, participants only receive bonus points for the peer assessments. As our results run in the same direction when limiting our analysis to courses with very similar team tasks, we do not focus on those differences in the paper at hand.

The graded team assignment consists of different workflow phases: anonymous evaluation of randomly assigned submissions of fellow teams [14], optional evaluation of the team members in regard to their individual contribution to the teamwork as well as their organization and social skills within the team and rating of the feedback from peers to reward reviewers that wrote helpful reviews with additional points [19].

For the peer assessment, overall grades are calculated based on the per-rubric median score [19]. It allows us to grade the team members individually. As such, we are following established best practices [20, 14].

### *B. Related Research*

Women in STEM subjects are confronted with several structural and interpersonal challenges, ranging from gender discrimination, sexual harassment, insensitive or disparaging comments made about their gender, and sexism as well as personal and professional identity-related challenges. These can concern identity conflicts, self-esteem issues, and a challenged sense of self, which can deteriorate a participant's performance [21, 22.]

Perkowski [23] as well as Astleitner and Steinberg [24] identified a small effect of gender on academic performance in online-learning environments favoring females over their male peers.

In addition to that, Brooks, Gardner, and Chen (2018) found that female data scientists in video backgrounds and female aides for tutorial videos induce "strong positive effects on overall course activity and discussion posting behavior by female students" [25] and that "subtle personalized alterations of educational environments can influence students' engagement patterns in large-scale digital learning environments [25].

Belenky et al. explain that women especially develop as informed participants in a course when instructors allow learners to collaborate to build knowledge [26]. Byrne recommends "a constructivist, supportive learning environment in which learners discuss their ideas and the instructor serves as a facilitator more than an expert" [29] as well as providing learners with personalized feedback especially for supporting women's cognitive development [29].

Examining the aggregated team performance and dropout data in a selected programming course ("Introduction to Object-Oriented Programming in Java"), Staubitz, Teusner, and Meinel (2019) have observed: "all teams that have managed to submit something have been mixed teams. 21 of the 33 male participants (64%) dropped out of the team task, while only 4 of the 14 female participants (29%) dropped out of the team task" [8]. Staubitz and Meinel nevertheless detected a slight peak in dropout rates of teams where one woman is working with an otherwise all-male team (80:20 ratio given a team size of five to six members) [1]. Sackett, DuBois, and Noe found out, that "women received lower ratings when the proportion of women in the group was small, even after male-female cognitive ability, psychomotor ability, education, and experience differences were controlled" [30]. Concerning the impact of a high performing learning environment on students' self-assessment, Mann, Legewie, and DiPrete determined that high performing peers influence the self-evaluation and, in turn, the course choices of their male fellow students more negatively than their female co-learners with comparable abilities [31].

Beyond the scope of the experimental study the experimental studies mentioned above, there seem to be a lack of empirical insights into men's and women's performance in graded team assignments in MOOCs based on large sample sizes to date.

## IV METHOD: DATA COLLECTION AND ANALYSIS

Based on the findings derived from literature and studies mentioned above, fifteen MOOCs targeting three areas of IT, business innovation and the Design Thinking [27] audience (see Table 1) [17] have been developed, including graded team-based assignments. They were carried out on our MOOC platforms openHPI, openSAP, and mooc.house. We have analyzed the performance data of 2537,4 enrolled participants in these MOOCs in 839 teams on the team and especially on the individual level. 4,279 of the participants stated their gender. About three quarters of them were men and 1,112 were women. The proportion of women in the team-based assignments ranges from an average of 15 percent in a MOOC about business innovation to 48 percent in a Design Thinking MOOC. The socio-demographic and geographical background of the participants in the team tasks more or less mirrors the total course population. We see that mostly high performing participants are registering for the team tasks. Furthermore,

TABLE I. MOOCs CONTAINING A GRADED TEAM-BASED ASSIGNMENT

| ***Courses*** | | ***Platform*** | ***Language*** | ***Enrollments in teams*** | | ***Teams*** |
|---|---|---|---|---|---|---|
| ***Topic*** | ***Title** (Abbreviation)* | | | ***Total*** | ***Women** (%)* | ***Total*** |
| Object-oriented programming | Objektorientierte Programmierung in Java *(javaeinstieg2017)* | openHPI | German (with almost 100% native speakers) | 1,439 | 22 | 256 |
| | Object-Oriented Programming in Java *(java1)* | openSAP | English (considerably less native speakers) | 743 | 21 | 119 |
| | Java Capstone Series Pt. 1 *(java-capstone-1)* | openHPI | | 222 | 17 | 32 |
| | Objektorientierte Programmierung in Java–Schul-Cloud-Edition 2018 *(javaeinstieg-mint-ec-2018)* | openHPI | German | 62 | 31 | 13 |
| | Java Workshop: Einführung in eine Java-Programmierumgebung (IDE) *(javawork2017)* | | | 43 | 21 | 22 |
| Business Innovation | Enabling Entrepreneurs to Shape a Better World *(sbw1)* | openSAP | English | 253 | 41 | 39 |
| | Designing Business Models for the Digital Economy *(bmi1-1)* | | | 651 | 27 | 89 |
| | Intrapreneurship–Make your Business great again :-) *(bizmooc2018)* | mooc.house | | 156 | 41 | 28 |
| | Designing Business Models for the Digital Economy *(bmi1-pilot1)* | openSAP | | 79 | 29 | 17 |
| | *(bmi1-pilot2)* | | | 44 | 15 | 9 |
| Design Thinking | Developing Software Using Design Thinking *(dt1)* | | | 373 | 35 | 62 |
| | *(dt1-1)* | | | 514 | 29 | 66 |
| | *(dt1-2)* | | | 333 | 32 | 48 |
| | *(dt1-pilot3)* | | | 88 | 26 | 19 |
| | *(dt1-pilot4)* | | | 94 | 48 | 20 |
| **Sum/average** | | | | **2,537** | **29** | **839** |

about 60 percent of the learners, who signed up for a team task were no-shows (in the team task) and 12 percent did not review their peers.

In addition to this study, we evaluated the team-based assignments in MOOCs using surveys. Our objective was to gain further accurate data on virtual teamwork and base decisions such as matching criteria for the teams on empirically gathered information. 366 learners filled in these questionnaires. With this survey data, we are able to analyze learners' preferences (e.g. concerning team structures) as well as conducive or hindering circumstances of team-based assignments in more detail. Based on our research interests we operationalized our key variables and formulated the survey questions following validated questions from social sciences whenever possible. The questionnaire was designed following a team-based approach [28]. It contains closed questions with multiple answers and open questions with open-ended answers to get valuable additional information in detail, and it was pre-tested with our partner organizations.

The methodology applied is a combination of desk and field research following a mixed-method approach of quantitative and qualitative analysis. Based on the quantitative MOOC and survey data, we conducted descriptive and inferential statistics such as frequency analysis, contingency tables, unpaired t-tests, and regression analysis. Thereby, we describe the characteristics of the large amount of raw data in a graphic way, to better understand as well as interpret the predictions concerning the research questions mentioned above and verify or refute our hypotheses. In addition, we reviewed the small amount of open-ended responses to the survey and chose essential explanatory or additional insights for presentation.

## V RESULTS AND FINDINGS

In the following paragraph, the most relevant data of the quantitative analysis of team composition and performance by gender is provided.

### A. *Team Composition by Gender and Success of the Team*

To reveal patterns in the presence of overplotting, we generated scatterplots and fit lines with geom_smooth, a package for the free statistical software R [32] for our business, design, and IT MOOCs. Based on these calculations, the relationship between the number of women in virtual teams and the teams' grades from peers seem to depend on the specific course category.

In the MOOCs on business innovation, exclusively male teams and teams with less than 20 percent women reached on the average less than 80 percent of the points in the team assignment, whereas teams with a proportion of 40 percent women received on the average about 85 percent of the points (see Fig. 1).

Teaching in Design Thinking avoids elements of traditional assessment (to some degree). During these courses, students worked in teams to improve the experience e.g. for vending machine users. The teams applied the Design Thinking concepts and went through the entire Design Thinking process, which they learned in the course–starting with research, this process makes (made) it possible to gain valuable insights into users' needs and pain points, and defining a problem statement. Based on this, they develop creative ideas to solve the users' problem, build a prototype and test it with potential users to improve their solution even further. In this peer assessment team, the teaching team decided to assign 20 points for completely accomplished grading rubrics, 15 points for partially fulfilled rubrics and 0 points for requirements that were not considered at all. The majority of teams in these courses received 100 percent for their assignments, for the most part regardless of/ independent of gender. All but three teams–with a proportion of 20 to 40 percent of women–got above 80 percent (see Fig. 1). Accordingly, even though the majority of teams, who passed the assignments, earn good grades, the specific task and grading rubrics seemed to have an additional impact on the grades from peers.

Nevertheless, in the MOOC "Objektorientierte Programmierung in Java" *(javaeinstieg2017)*, conducted by three female and two male facilitators, a large number of women in the team assignment completed the task with good grades, which makes for gender heterogeneous team experiences.

### *B. Success and Performance in Virtual Teams by Gender*

Altogether, women completed the team-based assignments more successfully than their male fellow students. Corresponding to Perkowski's findings [23], on the average, women, who passed the peer assessment, receive slightly, but at the significant level of at least $p \leq 0.05$, better grades than their peers (81% vs. 79% of attainable points). With respect to the different workflow phases of our Peer Assessment, we learned that our female participants are particularly hardworking reviewers. They wrote more individual reviews to grade the other teams than men did. Thereby, they receive significantly more bonus points for reviews (81% vs. 76% with three reviews corresponding to 100% and six possible reviews implying to 200% of bonus points for reviews).

Likewise, women add value concerning team processes and the functioning of the team in terms of individual contribution, organization, and social skills during the teamwork [1, 20]: Women receive slightly but significantly higher scores from their team members than men (76% vs. 72% of the possible number of bonus points for this criterion). These findings are in line with empirical studies, which found out that on average women do better than men did [23]. On the one hand, numerous girls are smarter than their male peers are, especially among those who persist through whatever discriminatory mechanisms, e.g. in male-dominated class environments [33]. On the other hand, due to gender-based role socialization [23] girls frequently go the extra mile, are particularly hardworking and follow the regulations of our educational system closely.

### *C. Preferred Matching Criteria for Teams*

After the two programming MOOCs *java1* and *java-capstone-1*, we evaluated our participants' preferred matching criteria for teams. More than 40 percent of the 332 survey participants, who answered this question prefer a similar time commitment to work as distributed. Up to 22 percent, especially in the MOOC *java1* prefer diversity of age, professional background and gender. 14 percent of our interviewees want


Fig. 1. Percentage of Women in Teams and of Percentage Points Given to Peers

local teams who they can meet face to face, and about five percent favor team members with the same native language, especially in the Anglophone MOOC *java1*. Less than five percent feel comfortable in homogenous teams in regard to age, background and gender or want to work in a team with fellow students with whom they previously interacted in the discussion forum (see. Fig. 2). In addition, some interviewees clarified within the free-text answer, that they prefer a combination of several matching criteria. For example, a woman recommended "diversity in terms of the same or a close time zone along with the age, professional background and gender" and a man "would like a balance (i.e. a balance between time commitment and diversity)". To exceed these different preferences, one woman noted: "I have no idea what matters more (I worked with very diverse colleagues, and I know that various compatibility criteria sometimes don't work)". Another woman commented on our implemented matching algorithm of time commitment and heterogeneous age, professional background, as well as gender saying "the groups were well done, with the right criteria".

Interestingly, the amount of men, who prefer the diversity criterion is twice as large as the amount of women (24 % vs. 12 %). On the one hand, our male survey participants seem to wish for new impetus in their working environment. On the other hand, the majority of our female survey participants, who are (still) engaged in the IT sector, seem to be used to working in a male-only team and do not (or no longer) attach importance to gender diversity. In such a case, the participant has found a way for herself to work successfully in such a team. The amount of women is (at least slightly) higher than the amount of men concerning the locality of team members, native language, and previous interaction in the discussion forum (8 % vs. 3 %). These figures by gender are based on the post-team task- survey of the MOOC *java1*. 309 out of 743 learners answered this questionnaire (202 men and 52 women). In contrast, only 57 out of 523 learners participated in the same survey, which we conducted in the MOOC *java-capstone-1*, a course in which, unfortunately, only 36 women enrolled. Under these circumstances, it would be pointless to analyze this subset of data by gender.

## VI. Discussion, Implications and Conclusion

On the team level, the relationship between the number of women in virtual teams and the teams' grades from peers is very complex and depends on the specific course. In our courses on business innovation and Design Thinking, team grades are mainly independent of gender, whereas in an IT MOOC virtual teams with a large number of women characteristically earned high grades on coding assignments and opened up further opportunities for successful teamwork in online courses.

On the individual level, we found out that women perform slightly but consistently better in virtual team-based assignments than men do, which can initiate additional prospects for good performance of women in STEM. Potentially, several barriers for women in STEM identified in previous studies (e.g. subtle discrimination in male-dominated teams, poorly perceived self-efficacy for using technology [29], and a Luddite socialization of women [34]) could be overcome by such successful team experiences, even in male-dominated IT MOOCs.

In our future analysis of the team performance of homogeneous as well as heterogeneous virtual teams, and the performance of men and women in those teams, we will focus on successful mixed as well as homogeneous teams with different gender constellations. We will further look at their success factors as well as their dropouts by gender in more detail. Another area of interest is male and female performance in light of team performance as a whole.

Concerning evaluation within teams, we will figure out, for example, whether men or women evaluate their male and female student counterparts differently or similarly based on certain parameters, such as an individual's contribution to the teamwork. As there are different possibilities for gender heterogeneous (e.g. varied emphasis on team tasks) and gender

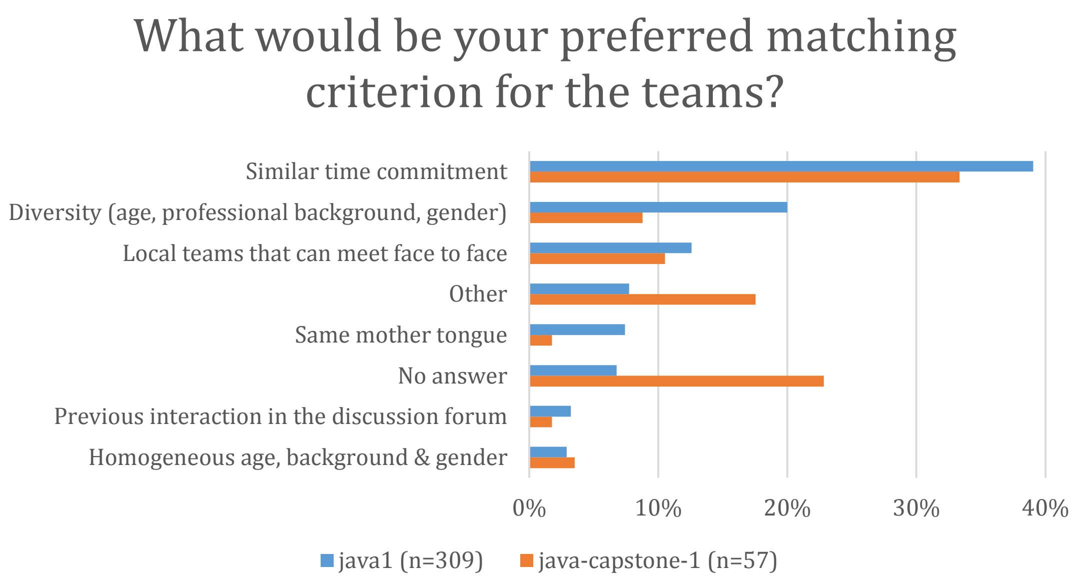


Fig. 2. Preferred matching criterion for the teams.

homogeneous teams (such as effective work on team tasks based on team members' similar opinions and values), we will analyze in which gender constellations men and in which team compositions women perform particularly well. Furthermore, we will experiment with different matching algorithms for digital teamwork to improve team performance and to better predict and prevent dropouts in virtual team assignments. We will further analyze the following areas: if it is a promising strategy to distribute female participants equally in all teams, whether it would be favorable to have some teams composed of 40 percent women and other teams made up of only male participants, and if it could be helpful for some female participants to work in a women only team on a certain topic. In addition, we will focus on the influence of teaching teams' gender on the activity in team-based assignments of female students.

We also want to investigate whether there are similarities or differences concerning the preferred matching criteria for teams by gender in different cultural backgrounds, at least between our three main groups of groups of German, Indian and American male and female participants.

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