



# Analysis of MOOC Forum Participation

**Oleksandra Poquet**

School of Education  
University of South Australia

**Shane Dawson**

Learning and Teaching Unit  
University of South Australia

The integration of social learning practices into massive open online courses (MOOCs) raises numerous learning and teaching challenges. While research into formal online education has provided some insight into the strategies for facilitating online learner-to-learner and learner-to-teacher interactions, the differences between MOOCs and more mainstream online courses impede any direct adoption and application. This paper reports a study linking the analysis of MOOC learner and teacher interactions to those in formal online education. The study compares MOOC forum activity of the individuals occasionally posting on the forum, and the ones contributing to the forum regularly. Through the social network analysis of forum posting and voting, we highlight the similarities and differences in how the networks of regular and occasional participants develop and interact. The findings provide some insight into how social learning practices can be promoted regardless of the course population size.

**Keywords:** social learning, MOOCs, social network analysis, forum interactions

## Introduction

The rapid push for scaling online learning among universities has in part manifested through the emergence of massive open online courses or MOOCs (Altbach, Reisberg, & Rumbley, 2009). A MOOC is an online non-accredited course, with flexible registration, and offered free of charge. Given the volume of students undertaking massive open courses, this model of education attracted much media attention for its perceived capacity to disrupt formalised tertiary education structures (Bulfin, Pangrazio, & Selwyn, 2014; Hollands & Tirthali, 2014). Despite MOOCs' potential for widening user access to education, there remain numerous 'for' and 'against' arguments related to its quality and methods of instruction. The primary narrative so far has centered on the challenges of teaching and learning in the MOOC context and the development of a sustainable business model.

The integration of social learning practices into open online courses remains a contested issue for MOOCs. Contemporary education and learning theory support the implementation of pedagogies that enable learning with others. However, the effectiveness of facilitating social learning activities becomes problematic when students reach well into the thousands (Miyazoe & Anderson, 2013; Stewart, 2013). Prior research in formal online education has identified some practices and processes that lead towards active learner-to-learner and learner-to-teacher interactions. For example, the use of meaningful tasks to prompt the exchange of ideas, teachers' timely feedback and checks for understanding, as well as fostering a sense of community, has been noted to increase the quality and quantity of interactions (Darabi, Liang, Suryavanshi, & Yurekli, 2013; Ravenna, Foster, & Bishop, 2012). Yet, even if the suggested techniques were implemented at scale, empirical studies of MOOCs do not offer sufficient evidence to justify a simple transfer and adoption of formal online education practices.

The direct application of effective practices from formal online learning to the MOOC context is prevented by the specific idiosyncrasies of MOOCs. In a formal online course, students enrol to receive credit and formal recognition of mastery, largely providing the student cohort with a shared goal. Conversely, in a MOOC students are driven by diverse goals, from sampling course content, to being interested in a subject, or in peer interactions (Eynon, 2014). Furthermore, MOOCs are much more asynchronous than conventional online education (Mullaney, 2014). In stark contrast to the compulsory start and finish times in formal online courses, individuals can join most MOOCs at any point of time in the course duration.

This paper reports on a study linking the analysis of MOOC learner and teacher interactions to those

in formal online education. To do so, we first identify a group of MOOC participants with a certain level of regularity in their forum participation. This sub-group of MOOC participants is comparable with students in more conventional online offerings where instructors expect learners to post on the forum with a certain repeated frequency. A social network perspective is applied to analyse how the network of regular forum participants develops overtime, in relation to that of the entire MOOC cohort. The paper discusses the similarities and differences between the dynamics of regular and occasional MOOC participants, in light of the current research in social learning in MOOCs.

## Literature Review

Much recent empirical research has been dedicated to MOOCs offered through a centralized platform such as edX or Coursera (Gasevic, Kovanovic, Joksimovic, & Siemens, 2014; Veletsianos & Shepherdson, 2015). The availability and access to student interaction data collected during the course offering has enabled institution-based research groups to rapidly investigate MOOCs from many alternate research perspectives. As students interact with course content and with each other on the discussion forum, MOOC platforms record their clicks and logs, as well as associated information, such as time of the logs, or content of the posts. MOOC researchers then extrapolate the trace data to signify student learning and engagement. For example, early efforts to understand MOOCs resulted in analyses of how the entire cohort of enrolled students interacted with the course resources, and which typologies of participants could be observed (Coffrin, Corrin, de Barba, & Kennedy, 2014; Ferguson & Clow, 2015; Kizilcec, Piech, & Schneider, 2013). These analytics suggest that individuals exhibit diverse preferences as to when, how and in which combination they watch lectures, use the forum, or complete assignments, if at all. It has also been observed that MOOCs experience a sharp decrease in participation within the first week(s) of the course before a gradual stabilization of participant activity occurs (Dawson, Joksimović, Kovanović, Gašević, & Siemens, 2015). In short, the numbers of MOOC participants decrease overtime and at different points of the course offering diverse clusters of participants present alternate activity patterns.

While investigations of participant activity counts remains the dominant strand of MOOC research there is emerging work exploring student social engagements in forum discussions. In the online education context, discussion participation represents learner-to-learner and learner-to-teacher interactions that are instrumental to shortening spatial, temporal and psychological distance separating the learners (Moore, 1993; Thompson, 2007). The studies of social interactions in MOOCs target the relationship between students social positioning and the quality of posted text with students' overall course performance, perseverance, and learning. For example, Jiang et al. (2014) demonstrated that for some courses a student's network centrality measure derived from their discussions with peers was associated with a higher academic performance. In relation to course persistence, Rose et al. (2014) found that students' inability to become a part of the forum conversation was associated with a high level of course disengagement. Similarly, Yang et al. (2015) investigated posted messages expressing confusion, and observed that the authors of such posts are more likely to disengage from the course, unless their confusion was resolved. In relation to learning, insights from forum analysis tend to conclude that social learning in MOOCs resembles 'learning in a crowd' with its fragmented groups and weak relationships (Gillani, 2013; Gillani, Yasser, Eynon, & Hjorth, 2014; Milligan, 2015). Gillani has suggested that such fragmentation may not be detrimental to learning, as it could foster deeper conversations in smaller groups. However, Kellogg and colleagues (2014) counter this argument noting that forum conversations are typically at a low-level in terms of co-construction of knowledge. The authors demonstrated through the content analysis of the forum discussions that only 7% of all conversations go beyond the negotiation and co-construction of knowledge phases.

Structural and content analysis of social interactions in MOOC forums provide valuable insights into learning at scale. However, studies taking on these methods commonly analyse the entire MOOC cohort, and do not overtly integrate the findings from prior research on participation patterns. In this study we suggest that connecting learner typologies with the inquiries into the structure and content of forum discussions will allow a more fine-tuned analysis of MOOC interactions. In their work on learner sub-populations, Ferguson and Clow (2015) distinguished various groups, among them so-called *Returners*—individuals comprising around 6-8% of the entire MOOC cohort, and characterized by a more regular participation. In alignment with Ferguson and Clow's work, we delineated a sub-population of learners consistently present on the forum and applied social network analysis to investigate the structure of the entire cohort's network and the structure of the regular participants'

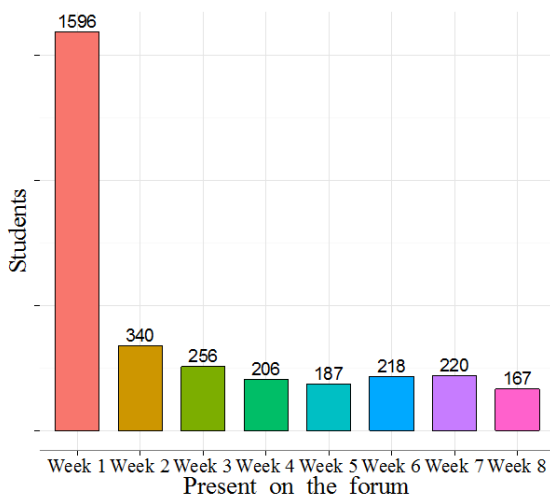
network. The study’s research question was: “How did the network of a set of regular forum participants develop compared to the network of the entire cohort in a MOOC?”

## Methods

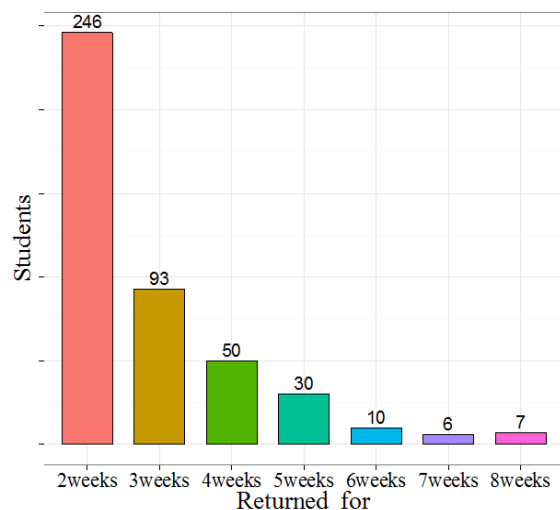
To address the posed research question, we analysed student interpersonal platform-based interactions of a Solar Energy MOOC offered by the Delft University of Technology via the edX platform. The duration of the course offering was for eight weeks over September – December 12, 2013. It enrolled 57091 students, and 2730 students received a certificate of completion. This MOOC was designed as a bachelor level foundation course, and required basic knowledge of physics and such mathematical skills as integration and differentiation. The course included over 9 hours of video lectures, as well as physics animations, numerous convergent quizzes, four homework assignments and three exams, with estimated 8 hours of workload weekly. Several staff members were appointed to look over the forum. After the first few days of the course active students were selected as community assistants. No special activities were offered to prompt interactions on the forum. Yet, the forum discussions were distributed within the course, as they were embedded next to the videos and assignments. Such strategy made it easier to locate specific discussions, while still within the platform. The course participants did not extensively use social media for course interactions. Facebook group set up by the participants comprised 171 people, including the staff, but was not as vibrant as the edX forum, and was mostly used for sharing links. Furthermore, although the course offered a Twitter hashtag for connecting outside of the platform, we have not detected much activity on Twitter in regards to this MOOC.

In this study, we will refer to the main population of the course as the *all learners* group. This group comprised some 2343 forum participants who created 4727 posts reciprocated by others by a reply or a vote within the eight weeks of MOOC’s duration. Overall, 3820 students participated in the course forum. The group of *all learners* excluded some 1477 individuals whose forum contributions were never reciprocated by either reply or a vote.

The overall pattern of participation on the MOOC forum by the entire cohort followed a typical engagement curve (Figure 1). Since the engagement curve does not capture the regularity of participation, but simply the volume of weekly activity, we also analysed the frequency of student returns to the forum for the entire course cohort (Figure 2). Based on these analyses, participation in at least three weeks of the course was chosen as the criterion for the inclusion in the group of *regular participants*. As the result, a group of students who returned to the forum to post or vote for (any) three weeks or more weeks of the course comprised 196 individuals. We will refer to this sub-population as *regular participants* group.



**Figure 1. Volume of forum participation of the entire MOOC cohort**



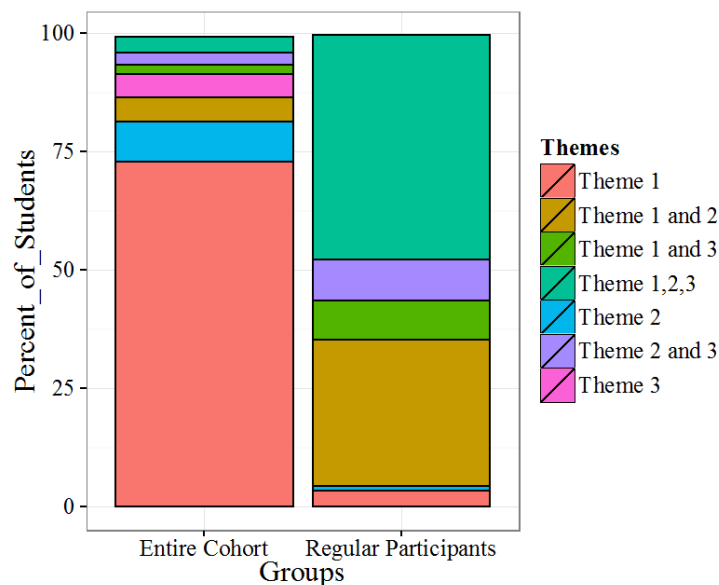
**Figure 2. Frequency of forum participation of the entire MOOC cohort**

Additionally, we considered the MOOC as lasting three thematic modules, in lieu of a simple week-by-

week analysis for the 8-week<sup>3</sup> course duration. Each thematic module was based on the course design (topic modules) and lasted from 2-3 weeks. An assessment task marked the completion of each theme. Figure 3 summarises the presence of students during each thematic module of the course. Almost 75% of *all learners* engaged in social interactions for the first 1/3 of the course. However, the vast majority of the *regular participants* sought interactions with peers or instructors during 2/3 of the entire course content. These observations validate the assumed comparability between *the regular participants* and students enrolling in more formal online learning courses. Fifty percent (50%) of the *regular participants* were active on the forum during all three thematic modules; and 40% of the *regular participants* were active during the first two themes.

The course contained teaching staff and community assistants (CAs)<sup>4</sup> (11 people). Since these individuals were active and present on the forum, they were all a part of the *regular participants* network. Their role in the forum was to actively engage with participants, to address questions and promote discussion of course concepts. To capture and distinguish these committed individuals from other *regular participants* in the structure of the network, we have constructed two versions of the *regular participants* networks: one that included staff and community assistants, and one that excluded them.

To analyse the evolving network configurations we undertook a series of undirected weighted networks for *all learners* and *regular participants* (both with and without staff and CAs). These networks constituted participants' co-occurrence in forum conversations. A conversation was defined as taking turns and contributing answers to one specific question or problem. That is, a co-occurrence of participants in the same forum thread did not result in a connection within the constructed network, if the individuals did not actively engage with one another in relation to the specific question. To illustrate, if A posted a question, and B and C replied to it, then A, B and C would all be linked by undirected edges in a graph. If in the same conversation D up-voted A's post, the graph would also connect A and D by an undirected edge.



**Figure 3. Students active on the forum per thematic module**

To compare the development of *regular participants* network against *all learner* network, we calculated the network centralization measures (i.e., betweenness, closeness, degree) and the density for the networks of *all learners*, *regular participants*, and *regular participants without staff and CAs*. Density is considered as a measure of network cohesiveness, and indicates the ratio of all present connections between participants in relation to all possible connections (Carrington, Scott, & Wasserman, 2005). Centralization is a network-level measure that encapsulates the variation of

<sup>3</sup> During the first three weeks of the MOOC students were learning introductory concepts that belonged to Theme 1. The second theme lasted next three weeks of the course, and Theme 3 was on offer for the last two weeks.

<sup>4</sup> Community assistants (CAs) - students highly active in the first weeks selected by staff to help with the forum

individual centrality measures in a given network for: i) degree—the number of people one has co-occurred with; ii) betweenness—the measure indicating whether the individual has co-participated with other students who are otherwise unconnected; iii) closeness—the number of connections that exist between participants to link them directly, also denoting the “compactness” of the network (Wasserman & Faust, 1994).

Centralization and density of the *regular participants* network in relation to the *all learner* network were plotted overtime at four different time points representing the identified course thematic:

- Stage 1 for the first week of the course;
- Stage 2 for thematic module 1 in weeks 2 and 3;
- Stage 3 for the thematic module 2 in weeks 4, 5 and 6;
- Stage 4 for thematic module 3 in weeks 7 and 8.

Data manipulation and analysis was undertaken using the *igraph* package in R (Csardi & Nepusz, 2006).

## Results

This paper analysed how the network of *regular participants* developed over the course offering compared with the network of the entire MOOC cohort. Given that *regular participants* returned to the forum, and were a relatively smaller group, we expected that this sub-population would have a much more cohesive network structure, compared to a loose network representing the entire cohort. The analyses indicate that both the *all learners* and *regular participants* networks had a similar structure. While the networks contained a small group of highly interconnected individuals that interacted with many people multiple times, the majority of participants interacted infrequently and only with a few people. We observed that 75% of *regular participants* most commonly interacted with 1 to 24 people in the course, and communicated with the same person once, on average. Yet, the remaining 25% of *regular participants* interacted with 24 to 179 people during the course, with the frequency of interaction with the same person ranging from 3 to 147 times. These inferences are derived from Table 1, illustrating the degree distribution, which here represents the number of people a participant co-occurred in a conversation with; while the mean edge weight denotes the frequency of co-occurrence with the same individual.

A power-law distribution was observed in the *all learners* network. The majority (75%) of *all learners* interacted during the course with 1 to 32 people with an average frequency of once. The remaining 25% interacted with 32 to 593 people, with a frequency ranging from 1 to 147 times. It can be concluded that the most frequent interactions between the same individuals took place within the regular participants, since the maximum values for the edge weight are shared across the two networks.

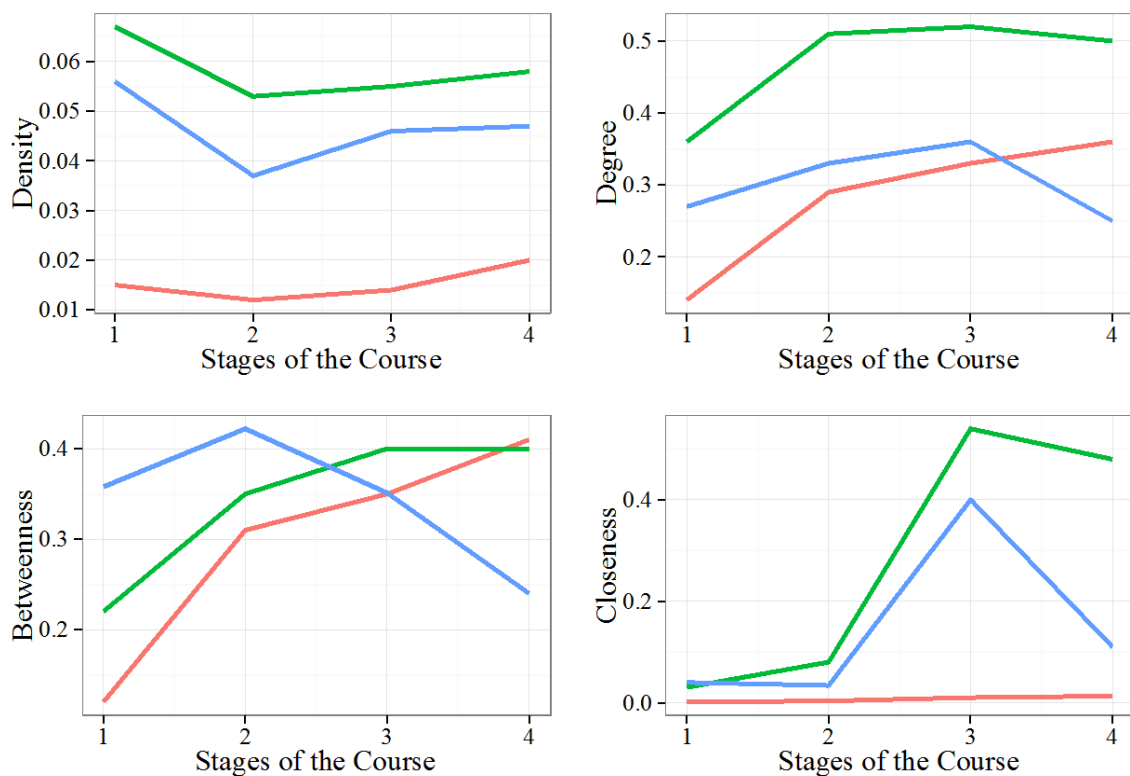
**Table 1. Description of All Learner and Regular Participants Networks**

|                          | All Learners | Regular Participants |
|--------------------------|--------------|----------------------|
| Nodes                    | 2434         | 196                  |
| Edges                    | 27559        | 2016                 |
| Density                  | 0.009        | 0.1                  |
| Centralization           |              |                      |
| Degree                   | 0.23         | 0.81                 |
| Betweenness              | 0.18         | 0.23                 |
| Closeness                | 0.0009       | 0.62                 |
| Degree Distribution      |              |                      |
| First Quartile           | 2            | 7                    |
| Median                   | 8            | 15                   |
| Mean                     | 22.6         | 20.5                 |
| Third Quartile           | 32           | 24                   |
| Maximum                  | 593          | 179                  |
| Edge Weight Distribution |              |                      |

|                                  |      |     |
|----------------------------------|------|-----|
| First Quartile                   | 1    | 1   |
| Median                           | 1    | 1   |
| Mean                             | 1.5  | 3.5 |
| Third Quartile                   | 1    | 3   |
| Maximum                          | 147  | 147 |
| Average Edge Weight Distribution |      |     |
| First Quartile                   | 1    | 1.4 |
| Median                           | 1    | 2.1 |
| Mean                             | 1    | 2.6 |
| Third Quartile                   | 1.32 | 3   |
| Maximum                          | 12.3 | 14  |

The network representing the entire cohort is loosely coupled, highly decentralized, and characterized by most individuals located in smaller interconnected parts of the network that are linked by several individuals who co-participate in these otherwise disparate clusters. The *regular participants* network is similar in structure. However, the network is much more centralized than the *all learners* network with a degree value of 0.81 and 0.23 respectively. The closer the centralization measure is to '1', the more highly centralized the network is, and marked by the clear boundary between its core and periphery (Scott, 2013). Given network's power-law distribution and low betweenness value, one can assume that those who participated in most conversations, i.e. having high brokering power, would also be connected to the highest number of people (degree). Besides being brokers between conversations, they would also shorten the distance between the *regular participants*, as well as control much of the information within the network thereby explaining the differences in the observed network centrality measures.

The pattern of development for the networks representing the entire cohort and more regular participants (both student-only and students-and-staff interactions) has been consistent up until Stage 3 (Figure 4). The network of the entire cohort retained its low density and low closeness centrality indicating that individuals were only connecting with a few people, and the network members were sparsely distributed. The period between Stage 1 and Stage 2 is marked by a growth in the degree and betweenness centrality measures. Such a dynamic signifies an increase in the network centralization post week 1 due to the emergence of more active participants. In contrast, *regular participants* network shows a steady change in structure from a loose to a more inter-connected network. Although its density remained low at all time points, its value is much higher for *regular participants without staff and CAs* suggesting that the regular participants activated more possible connections between each other, than those students participating infrequently. The much higher centralization and closeness of the *regular participants* network as compared to the same network without the staff and CAs points to the role played by this dedicated group of people. The staff and CAs provided a bridge between the structural holes in the network, thereby significantly reducing the distances among the actors. In conclusion, while still maintaining a loosely coupled structure, the regular participants formed stronger relational ties among its central actors and established their wide outreach to loosely interconnected periphery. Such a structure is reflective of the developmental stages of a community of practice.



**Figure 4. Development of *all learner* network (red), *regular participants* network including staff and CAs (green) and *regular participants without staff and CAs* (blue). Networks are described by their centralization (betweenness, closeness, degree) and density at four different stages of the MOOC**

The overall pattern of network development for this MOOC suggests an increase in activity among the *regular participants* network up until Stage 3. However, in Stage 4 the dynamics of development between the network of occasional and regular participants is reversed. The *regular participants* network in the last stage becomes less clustered; its members did not extensively interact with each other, as compared to the previous stages. On the other hand, we observe an increase of all group measures for the network representing the entire MOOC cohort. This divergence of the patterns is symptomatic of the increased activity among the occasional participants at the end of the course. The catalyst for the change in user behaviour may be contingent upon a contextual factor. During Stage 4 the staff announced the criteria for awarding a free educational trip for two MOOC participants. These criteria included a perfect score on the exam, as well as a certain level of forum participation. The motivation to fulfil such criteria led to a sudden increase in forum activity during the last two weeks of the course. The flurry of activity extended to individuals that had previously not engaged in discussion activity. For example, one learner who never participated in the forum, created over 300 posts during the final week (week 8), placing a posting into various conversations dating back to a time as early as week one. This person also numerously up voted their own posts to imply a greater level of prestige. Other students exhibited similar behaviour generating larger activity within the *all learner* network. This type of activity was not well received among the regular participants network with many individuals posting messages indicating their disapproval of such behaviour. It is plausible that this impacted negatively on regular participants' motivation thereby resulting in the observed diminished discussion activity.

## Discussion

This paper analysed the development of two learner networks (entire cohort and regular participants) evolving from participation in a MOOC discussion forum. The analyses suggest that the network structures observed between the 2 groups are not dis-similar. Regardless of whether forum participation has been sustained or occasional, the networks representing interpersonal interactions are loosely connected, clustered, with hubs of activity linked by the individuals with higher degree of

participation. Similar to Gilliani's et al.'s (2014) prior findings we observed that structurally limited conversations occurred in fragmented groups, and a small group of people participated across them. In these disparate conversations around 75% of the participants of the entire cohort, including those who posted regularly, were likely to have one-time encounters with the same person. While it is evident that the vast majority of connections made in the forum could be classified as weak and infrequent, a quarter of the interactions in the *regular participants* network were recurrent. In fact, there were pairs of individuals who interacted with each other in over a hundred of instances. This suggests that among this diverse and disparate network strong relationships can still be established.

The networks of *all learners* and *regular participants* resemble each other structurally. Even so, we presume that these two networks may be characterized by different modes of peer production processes. In open online environments individual commitment to collaborative knowledge production ranges from lightweight to heavyweight (Haythornthwaite, 2009). Within this continuum, a heavyweight mode represents strong-tie affiliation with community members, its purpose and peer-negotiated norms. From such a standpoint, infrequent ties formed through forum activity signal lightweight participation made up of interest-based contributions with low-level commitment to maintaining or creating relationships. Given that most ties between participants seem to be one-time occurrences, learning in a MOOC forum can be described as 'learning in the crowd'.

While for most participants in centralized MOOC forums the commitment to social interactions can be regarded as impersonal and lightweight, there are frequent interactions among the same individuals. A quarter of interactions in the *regular participants* network may be indicative of strong ties typical for heavyweight commitment to forum participation. Heavyweight peer production refers to the sustained contributions to the perceived community, as well as monitoring its viability (Budhathoki & Haythornthwaite, 2012). This study demonstrates that active students appointed to maintain the forum community are active contributors and broker information between conversations. These more active and engaged participants are central to the *regular participants* network, and are thus more likely to have frequent encounters with their fellow participants. Given that up until Stage 3, the network of *regular participants* was gradually becoming more interconnected, it can be assumed that students as well as community assistants co-occurred with each other time and again. Such co-occurrences may have resulted in shared history, and may have shifted from impersonal contributions to the one where participants identified each other. It is also plausible that norms of behaviour, interaction and participation were negotiated through this shared history. In this case, regular participants attitude to the sudden raise of 'random' contributions by the end of the course is a manifestation of 'them' vs. 'us' reaction. Such reaction would indicate their developed sense of membership in the group with perceived boundaries.

Processes of repeated interaction, norm negotiation, commitments to quality of collective products, are atypical to crowds, but characteristic of the communities. In this paper we can only hypothesize that these two networks represent overlapping social entities defined by different social processes. Characterizing the content of the more frequent ties was beyond the scope of this paper. Current research also did not offer straightforward insights into the nature or quality of the stronger dyadic relationships developed in MOOC forums. We can surmise that stronger ties would be sites for higher percentage of knowledge construction incidents than the low 7% observed by Kellogg et al. (2014) in the entire cohort. It is also reasonable to say that the individual active students are the hyperactive individuals keeping the spirit of the forum (Huang, Dasgupta, Ghosh, Manning, & Sanders, 2014; Papadopoulos, Sritanyaratana, & Klemmer, 2014). They are also probably proficient in learning from many people, which would then define them as experts in crowd-sourced learning, according to the research by Milligan (2015). Alternatively, in reference to the research by Yang et al. (2015), we can expect that the threads expressing confusion and left unresolved would be more typical to the 'occasional' participants, while the unresolved threads expressing confusion by *regular participants* are less likely to result in the disengagement with the course. Yet, these are mere extrapolations of the findings pertaining to research spanning an entire MOOC cohort. Further inquiries are required to identify how the strength of a relationship between individual actors in a MOOC influences the quality of discussion and depth of knowledge construction. Understanding the qualitative differences between ties of higher frequency in both *all learners* and *regular participants* networks, as well as learning about the attributes of individuals who share strong ties may aid current efforts to devise technology for matching learners for a synchronous conversations in a MOOC forum (Ferschke et al., 2015).

The findings from this study also provide some practical conclusions. By establishing the



comparability of the group of regular participants as similar to the formal online learning student groups opens up opportunities for transferring “best practice” and innovating teaching techniques within MOOCs. For example, we observe the importance of forum facilitators and highly active students in the development of the network. Prior research suggests that students in such social positions carry a higher sense of belonging than their less well-connected peers (Dawson, 2008). Our analysis indicates that highly active students and facilitators develop numerous ties of higher frequency. These individuals could potentially take on more of an instructional role by scaling feedback approaches and instilling a sense of belonging, in a manner that is reflective of a teacher in a more formal and bounded groups. However, such activities and roles can also lead to student dominance. In order to avoid such an event, as well as any potential for inadvertently exploiting volunteer efforts, an instructor may consider a rotation of community assistantship, thereby delegating the dedicated role to a number of active students.

The present study raises questions related to the types of methodologies and approaches that are effective for researching social learning at scale. To better comprehend the complexities of social learning in MOOCs, researchers’ need to apply appropriate and diverse theoretical lenses to alternate units of analysis – from an entire cohort to individual actors. Networked learning (NL) may provide a sound theoretical framework for describing the various overlapping relationships that co-exist in the complex social organizations that manifest in educational settings (Jones, 2004a, 2004b; Jones, Ferreday, & Hodgson, 2008). Analysing a social entity from the NL perspective does not bias or privilege the strong relationships that imply closeness and unity of purpose within a group of actors (Jones, 2004a, 2004b; Jones & Esnault, 2004). Prior research has well demonstrated the benefits of using NL as an interdisciplinary framework for the analysis of learning due to its capacity to address “multiple scales of groups at multiple granularities of analysis, with multiple methods and theoretical foundations” (Suthers, Hoppe, De Laat, & Shum, 2012). Integral to this work has been the development of methodologies to investigate NL. For instance, de Laat et al. (2007) have outlined the potential of social network analysis (SNA) to inquire about the nature of NL, while Jones (2004b) suggested that network analysis of the links and relationships in NL environments needs to be supplemented with a qualitative analysis of their nature. Consequently, there exist a number of methodological frameworks that utilize social network analysis and complementary methods and diverse techniques to contextualize it (De Laat, Lally, Lipponen, & Simons, 2007; Suthers, 2015).

In conclusion, it appears that analysing social interactions in MOOCs from NL perspective and through NL methodologies could further enrich our understanding of learning at scale. Such an approach would allow for the capture of social learning ties of differing strength, as well as defining their role and meaning through the qualitative analysis of such tie types, strength, as well as the socio-cultural dimensions underpinning the network structure and formation.

## Acknowledgements

The authors would like to thank TU Delft Online Learning, in particular Thieme Hennis and Pieter de Vries, for the assistance with obtaining the data, and Srecko Joksimovic for the preparation of the data for this analysis.

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