Social Network Formation and its Impact on Learning in MOOC-Eds

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Research Questions

This mixed-methods case study adopted a social network perspective in order to investigate patterns, mechanisms, and outcomes of peer interaction in the context of the discussion forums of two Massively Open Online Courses for Educators (MOOC-Eds) titled *The Digital Learning Transition in K-12 Schools* (DLT) and *Mathematics Learning Trajectories: Equipartitioning* (EQP). Both were designed for the professional development of K-12 educators.

This study addressed three primary research questions about network formation and the impact of this network on learning outcomes in MOOC-Eds:

RQ1. What are the patterns of peer interaction and the structure of peer networks that emerge over the course of two MOOC-Eds?
RQ2. To what extent do participant and network attributes (e.g., homophily, reciprocity, transitivity) predict peer interaction?
RQ3. To what extent do these interactions result in the co-construction of new knowledge?

Social Network Analysis, including blockmodeling and exponential random graph modeling (ERGMs), were used to address RQ1 and RQ2. To address RQ3, this study applied content analysis of participant postings using a pre-defined coding scheme.

Findings

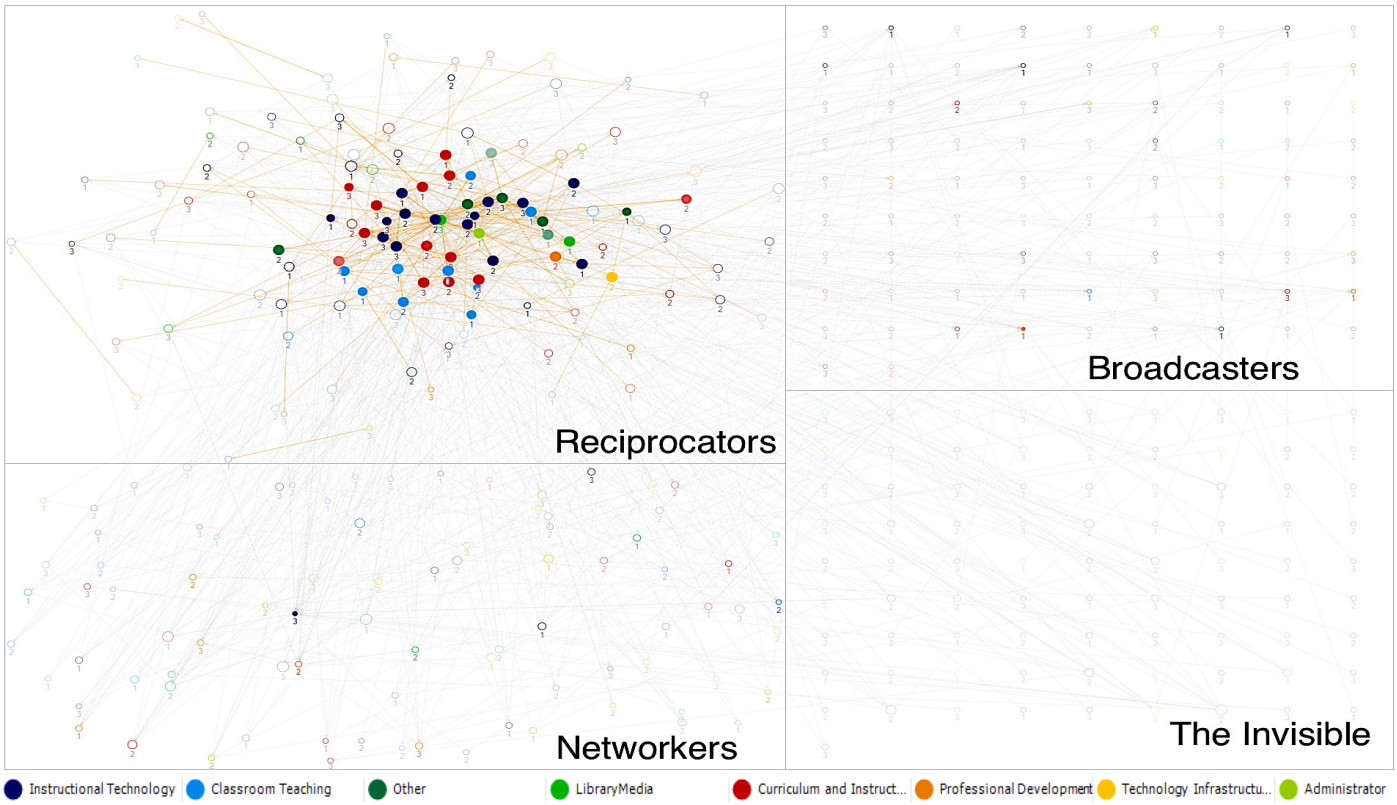
RQ1. Patterns of Peer Interaction. This study was guided by several theoretical propositions drawn from the literature on social networks, online learning, and social learning perspectives such as the Communities of Practice framework. Network level statistics provide an overall description of the social network including the number of peer interactions (edge counts) in proportion to those possible (density), the number of peers that participants replied to (outdegree) or received replies (indegree), and the extent of back-and-forth exchange in the network (reciprocity). Table 1 below provides a summary of these measures. At the network level, it was confirmed that both MOOC-Eds exhibited general characteristics common to online communities such as sparse scale-free networks, reciprocity, and a core-periphery structure. The majority of educators interacted with three or fewer peers, though each network consisted of a small proportion of “Core” of educators with numerous ties to each other as well as with those on the periphery. These core participants were also responsible for the vast majority of reciprocated exchanges in the network.

Table 1

Overall Network Measures for each MOOC-Ed

Network Metrics	DLT	EQP
Vertices	377	91
Unique Edges	1420	361
Edges With Duplicates	360	370
Total Edges	1780	731
Edge Weight Avg.	1.29	1.69
Reciprocated Vertex Pair Ratio	0.15	0.15
Reciprocated Edge Ratio	0.26	0.26
Graph Density	0.01	0.06
In/Outdegree Avg.	4.20	5.44
In/Outdegree Median	2	3
Indegree Range	0-57	0-30
Outdegree Range	0-41	0-37

Beyond the small core identified in each MOOC through core-periphery analysis, four general patterns of participation were identified through regular equivalence blockmodel analysis: 1) Reciprocators – educators who participated in at least one mutual exchange as illustrated by the double-arrowed orange line connecting two educators, 2) Networkers – educators who were both the recipients and givers of support, though not with the same individuals, 3) Broadcasters – educators who initiated a discussion thread and received replies from their peers, but neither reciprocated with those who replied, nor posted to threads initiated by others, and 4) The Invisible – educators who responded to the postings of peers, but received no responses in return (Figure 2). In both courses, reciprocators made up the largest proportion of educators.



Note: Node labels denote experience in education in increments of 10 (e.g. 1 = 0-10 years); Node size and opacity illustrate relative in/outdegree respectively; Disks indicate "core"; Orange lines indicate reciprocated edges (e.g. messages both sent and received); Line opacity indicates strength of interaction.

Figure 1. Sociogram of DLT Peer-Support Network Illustrating Core-Periphery and REGE Partitions

RQ2. Interaction Mechanisms. Another aim of this study was an attempt to leverage the extensive educator attribute data collected through the registration process of MOOC-Eds to provide insight into patterns of peer support associated with these attributes. It was proposed that these attributes would influence both the extent of involvement in the forums and the likelihood of forming a support tie with similar others. Specifically, it was proposed that: 1) relational mechanisms of reciprocity and preferential attachment would increase likelihood of a tie, 2) educators would differ in their overall connectedness in the network based on their professional role and years of experience, 3) shared attributes such role, grade levels, and geographical location would positively affect on the likelihood of tie, and 4) there would exist a mentoring aspect to MOOC-Eds in which support ties in the network between educators of differing year of experience would be greater than expected by chance. Across both MOOCs, significant effects were found for reciprocity, as well as differences in sociability by professional role, but not by their level of experience. No effect was found for preferential attachment. Finally, shared attributes including role, grade, gender, and location (homophily) significantly increased the likelihood of interaction in the DLT course, but not in EQP (Table 3).

Table 2

Summary of ERGM Model, Estimates and SE

	DLT		EQP	
	Estimate	*SE*	Estimate	*SE*
Baseline (Edges)	-4.50***	0.08	-2.05***	0.16
Structural Mechanisms				
Reciprocity	3.43***	0.09	1.80***	0.17
Popularity Spread	-3.33***	0.09	-3.38***	0.19
Assortative Mechanisms				
Role Homophily	0.17**	0.06	-0.01	0.11
Role Nodefactor[a]				
Administrator	-0.01	0.06	-0.25	0.14
Curriculum	0.08*	0.00	-0.32**	0.11
Library/Media	0.21***	0.05	--	--
Instructional Tech	0.06*	0.03	--	--
Teacher Educator	--	--	-0.08	0.06
Tech Infrastructure	-0.07	0.07	--	--
Prof. Development	0.00	0.05	-0.20*	0.11
Other	0.11**	0.04	-0.05	0.07
Homophily by Grade	0.17***	0.04	0.03	0.08
Homophily by Gender	0.08*	0.04	0.04	0.04
Experience Difference	0.04	0.04	-0.02	0.07
Experience Nodefactor[b]				
11-20	-0.01	0.03	0.12	0.07
More than 20	-0.04	0.03	-0.03	0.06
Desire to Connect	-0.04	0.03	-0.10	0.09
Proximity Mechanisms				
State or Country	0.71***	0.08	0.06	0.18
Geographical Region	0.05	0.06	-0.18	0.11
Group Assignment	0.54***	0.05	--	--
AIC	14847		3353	

Notes: * $p < .05$. ** $p < .01$. *** $p < .001$.

[a] Classroom Teaching serves as the comparison group

[b] Educators with 0-10 Years of Experience in Education serve as comparison group

RQ3. Interaction Characteristics and Knowledge Construction. A final aim of this study was to examine the various ways in which educators supported one another through analysis of the content of their interactions. A substantial portion of interactions in each MOOC included substantive feedback, well-reasoned arguments, and detailed solutions to issues raised during the course (Figure 2).

RQ 3. Support Characteristics and Knowledge Co-Construction

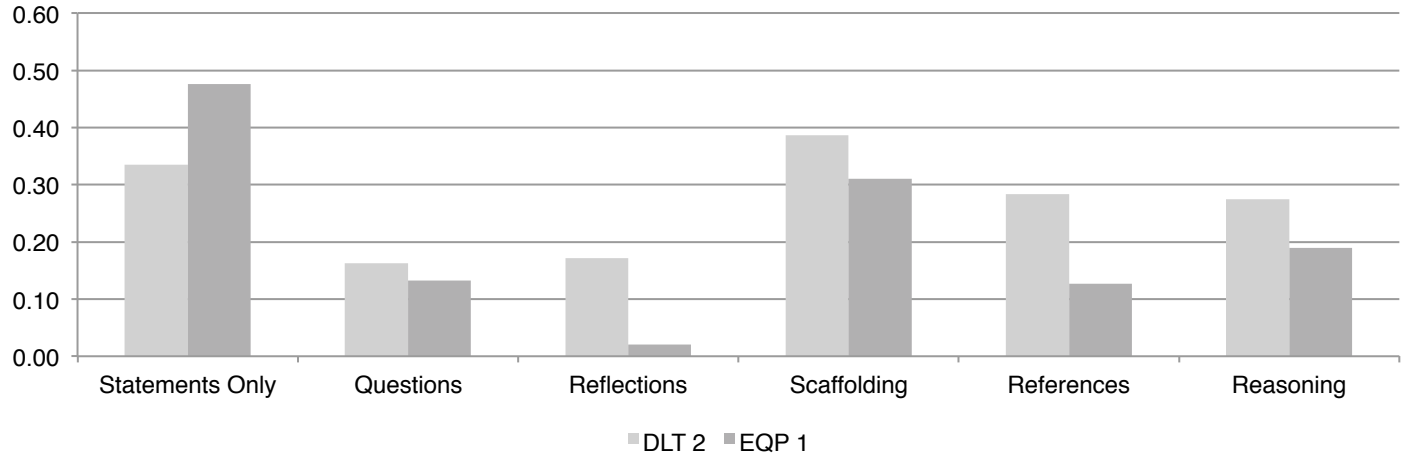


Figure 2. Proportion of Discussion Postings by Discourse Characteristic

Figure 3 also demonstrates that over half of the discussions in both courses moved beyond sharing information and statements of agreement (Phase I), by entering a process of negotiation and co-construction of knowledge (Phase 2 and 3), but seldom moved beyond this phase in which new knowledge was tested against experience (Phase 4), and consensus on diverging opinions was reached and implications for its application proposed (Phase 5).

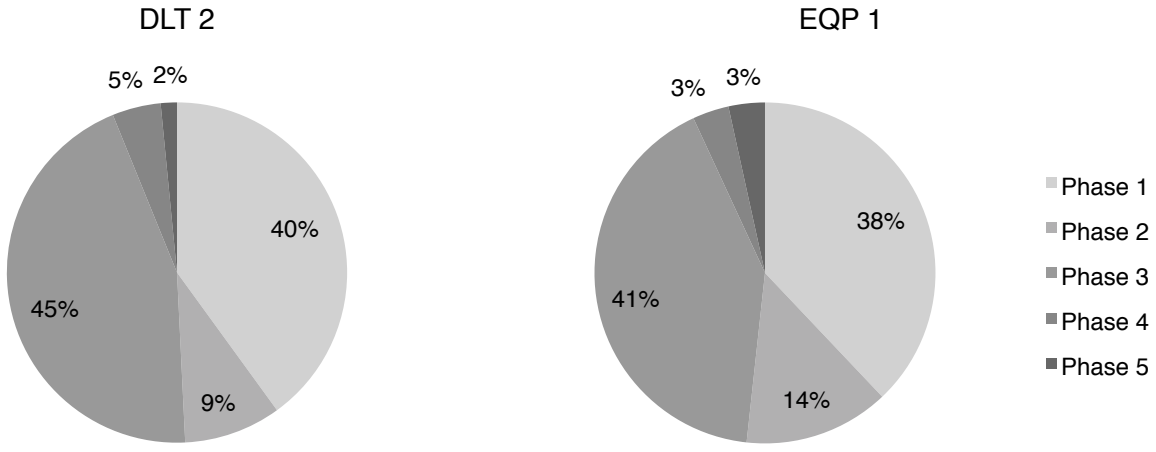


Figure 3. Highest Phase of Knowledge Construction Reached by Discussion Threads

Conclusions

This study demonstrated that even with technology as basic as a discussion forum, MOOC-Eds can be leveraged to facilitate meaningful exchanges among educators. While patterns of peer interaction varied by course and by subgroup, likely resulting from the different content focus and intended audience of each MOOC-Ed, the two networks as a whole shared many characteristics. Beyond simply describing the form and function of these networks, this study also illustrated some underlying network processes that shaped the development of these networks such as reciprocity and homophily. Finally, although this study was limited to two unique cases along the massive spectrum of MOOCs, the methods provide researchers with an alternate perspective for better understanding learning in these settings.

Future Work

The scope of this study was naturally constrained by limited funding and time, yet presents several interesting avenues for continued work. The most obvious of which is to expand this work in terms of size and setting. Naturally, generalizations cannot be drawn from two MOOCs from a single department at a university. Ideally, this study would have been comprised of numerous courses across multiple platforms to compare the networks that emerged and test the robustness of ERGMs used to model peer support mechanisms. In addition, the simplified model presented in this study was designed to examine a few theoretical propositions based on available data, rather than examine other potentially relevant mechanisms. For example, although attributes of the individuals were included in these models, attributes of the postings themselves were not. It is likely the timing, strength, and especially content of the postings impacted whether a peer would reply, and thus influenced the likelihood of a network tie. Although content analysis was performed on these postings, they were not included in SNA analyses because of the limited sample. One original intention of this study was to examine the subnetworks of these coded discussions to see if discussion length, and pattern of interactions within a discussion was associated with TAT characteristics and IAM phases. However, issues with reliability and the decision to recode discussions to ensure quality limited reporting to simple descriptives. Finally, aside from the impact of arbitrary grouping based on participant location, no specific MOOC design interventions were examined to see how these might influence network formation and promote more meaningful interactions. Incorporating the analytical approaches presented here with aspects of design-based research hold enormous potential for developing a set of MOOC specific design principles for fostering networking and community building among educators.