

CORRELATING TEACHERS' ENGAGEMENT IN ONLINE DISCUSSIONS WITH THEIR PERSISTENCE IN PROFESSIONAL DEVELOPMENT

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This paper reports on a correlation analysis of two cohorts of mathematics teachers' patterns of participation in online asynchronous discussions and their persistence in a sequence of professional development workshops. Findings indicate that increased access to colleagues' knowledge resources and more frequent dispersion of these resources across the social network related to persistence. We discuss how variations in the design of our online workshops may have impacted teachers' potential to persist in the professional development. The findings have implications for network-based instructional strategies that could increase mathematics teachers' potential to persist in online professional developments.

Keywords: Professional Development, Online and Distance Education

Objectives and Purpose

Developing discourse-rich instructional practices that are responsive to student mathematical thinking is a challenging process. Learning to implement such practices takes time and is unlikely to occur in “one-shot” professional developments or even a short workshop. Indeed, there is consensus that sustained duration is a feature of effective professional development that supports teacher learning and instructional improvement (Darling-Hammond et al., 2017; Desimone, 2009; Dille & Røkenes, 2021; Sztajn et al., 2017; Sancar, Atal, & Deryakulu, 2021). Online settings afford sustained professional development because they allow for flexibility in when, where, and how teachers participate (Fletcher et al., 2007). Further, online settings are less susceptible to local norms and instructional practices that can influence the focus of teacher collaboration (Cobb et al., 2001) and have counterproductive effects on their instruction (Munter & Wilhelm, 2020). Despite the importance of sustained professional development and the benefits of online settings for supporting teacher collaborative learning, little is known about the extent to which teachers persist in online professional development and how various factors, events, and conditions impact their persistence. In this paper, we report on our examination of relationships between patterns in teachers' interactions in our online professional development and their persistence in the workshops.

Theoretical Framework

We draw from social capital theory to frame our investigation of teachers' persistence in online professional development. A central assumption of social capital theory is that individuals have social, cultural, and intellectual resources and increased access to these resources through participation in a social network has many benefits for “upward mobility” (Burt, 1992; Coleman, 1988). Resources flow through a social network as individuals interact with one another (Light & Moody, 2020) and different positions in a network can support or constrain individuals' actions and access to resources (Burt, 2004). For example, those who emerge as *central* members of a network by interacting with a large proportion of colleagues have increased access to resources and a role in dispersing them throughout a network (Freeman, 1979).

Although there is no research we are aware of investigating relationships between teachers' centrality and persistence in professional development, studies of undergraduate education have

illuminated such relationships (Dawson, 2008; Thomas, 2000; Tinto, 1975). For example, Zwolak et al. (2017) found that students with higher centrality in an undergraduate physics class social network were more likely to enroll in the next class in the program. Furthermore, in a randomized control trial, Turetsky et al. (2020) implemented an intervention that supported students in becoming more central in a “gateway” bioscience course social network. Students in the intervention group that increased their centrality were more likely than the control group students to take the next course in the bioscience sequence. Drawing from these studies and social capital theory, we conjecture that teachers’ increased access to and engagement with colleagues’ resources in online discussions could impact teachers’ overall interest in professional development and potential to persist. The current study takes a first step at investigating this conjecture by correlating teachers’ centrality in online asynchronous discussion forum conversations with their persistence in a sequence of three online workshops.

Methodology

This research was conducted as part of an online synchronous and asynchronous professional development that featured a sequence of three 6-week workshops. The workshop goals included supporting mathematics teachers in shifting towards more student- and discourse-centered instructional practice by engaging in problem-solving, examining student math work, and connecting these experiences to models of mathematics lessons, including the “Launch, Explore, Summarize” model, 5 Practices for Orchestrating Productive Mathematics Discussions, and the “5-E” model. Each workshop built on the previous one by further connecting teachers’ work to their classroom practice. Workshop one included four week-long online asynchronous discussion forum conversations that connected teachers’ collaborative problem-solving and analysis of student work to their classroom practice. These discussions prompted participants to make an initial post and to submit at least two response posts to their colleagues. Workshops two and three used teachers’ collaboration in workshop one as a context for thinking about how to provide effective feedback to students.

We recruited two cohorts of participants to complete the professional development workshops. The first cohort (C1) included 16 participants who completed workshop one together in the spring of 2021. The second cohort (C2) included 10 participants who completed workshop one together in the summer of 2021. The primary difference between the spring and summer version of workshop one was that the spring 2021 version was six weeks and the summer version was two weeks. We implemented the accelerated summer workshop so that participants could potentially take two workshops (one and two) in the summer. We offered the second workshop in summer 2021 to both cohorts and 13 of the 26 participants completed the workshop. We offered the third workshop in the fall of 2021 to the 13 participants who completed workshop two. Nine of these 13 participants completed the third workshop. The 26 participants have between 4 and 9+ years of teaching experience across K-16 grade bands and their geographical locations vary across the United States. 75% of the participants identified as female and 25% identified as male. The racial breakdown of participants is as follows: 70% White, 18% Black, 2% Latino, 8% Asian, 2% Native Pacific Islanders.

The two data sources for this study included participants’ interactions from workshop one discussion forums and persistence data across the three workshops. We defined an interaction as an occasion where a participant responded to their colleague’s post on the discussion forum. We modeled this collaboration with two social networks (one for C1 and one for C2), where the nodes represented participants and directed edges represented a response post from one participant to another. Using social network analysis, we generated the following basic network

characteristics for C1 and C2. C1: *edges*=153, *density* (the proportion of edges to possible edges)=52%, and *reciprocity* (the proportion of interactions that are reciprocated)=50%. C2: *edges*=77, *density*=56%, and *reciprocity*= 48%. We used a three-point scheme to denote participants' persistence in the workshops. Specifically, if a participant only completed workshop one (did not persist), we denoted their persistence with a zero. We denoted completion of workshop one and two with a one and completion of workshop one, two, and three with a two. We imported the interactional and persistence data into R (R Core Team, 2021) and used the *statnet* package (Butts, 2020) to conduct the analysis.

The analysis involved measuring participants' centrality in workshop one social networks and then correlating centrality measures to their persistence. Given the lack of research on teachers' persistence in online professional development, we used a range of centrality procedures such as out-degree (the number of posts sent), in-degree (the number of posts received), betweenness (a measure of dispersing information across the network), out-closeness (a measure of access to other's posts), and in-closeness (a measure of other's access to one's posts). Table 2 provides an overview of several participants' centrality measures (top and bottom rank ordered according to outdegree). Finally, we calculated the Pearson correlation coefficient and corresponding significance levels between participants' centrality measures according to their cohort and their persistence in the sequence of workshops.

Table 1: Centrality and Persistence Data

Cohort	Participant	Outdegree	Indegree	Betweenness	Out-Closeness	In-Closeness	Persistence
C1	P1	17	9	0.100788	0.761905	0.571429	1
C1	P2	15	16	0.079033	0.695652	0.666667	2
C1	P15	2	6	0.016052	0.457143	0.551724	0
C1	P16	1	2	0	0.410256	0.470588	0
C2	P17	18	7	0.131638	0.916667	0.55	0
C2	P18	15	9	0.389121	0.846154	0.785714	1
C2	P26	1	4	0	0.37931	0.578947	2
C2	P27	1	4	0.004798	0.478261	0.578947	0

Results

Table 2 presents results from the correlation analysis. We found a positive and significant correlation ($p < .05$) between cohort one's betweenness centrality and their persistence in the sequence of workshops. Betweenness centrality quantifies the number of times a participant falls on the shortest path (in terms of connections) between two other, unconnected participants in a network. In online discussions, this means that a participant with high betweenness centrality is responding to posts authored by participants who are not communicating with one another and increasing the dispersion of knowledge resources across the network. Thus, this correlation means that cohort one participants who more frequently dispersed knowledge resources across the network in workshop one were more likely to persist in the sequence of workshops.

We also found a positive and significant correlation between cohort one's out-closeness centrality and their persistence in the sequence of workshops. Out-closeness centrality is calculated by taking the sum of the reciprocal of participants' shortest outwardly directed path lengths (the number of "jumps" one makes in a network to get to their peers). In online discussions, this means that a participant with high out-closeness centrality has increased access to colleagues' knowledge resources through direct engagement with their posts or engagement in a thread initiated by a peer who they did not directly interact with. Thus, this correlation means that cohort one participants who had increased access to and engagement with colleagues' knowledge resources in workshop one were more likely to persist in the sequence of workshops.

Table 2: Correlation of SNA Measure and Persistence

SNA Measure	Cohort 1	Cohort 2	SNA Measure	Cohort 1	Cohort 2
Out-degree	0.4953055	-0.4804152	Betweenness	0.5720269*	-0.5694836
In-degree	0.4300999	0.04415746	Out-Closeness	0.5010315*	-0.5337503
			In-closeness	0.4885712	-0.2476399

*p<.05

Discussion

This report provides initial support for our conjecture regarding the importance of teachers' social capital through access to and engagement with peers' knowledge resources for their persistence in online professional development. These findings suggest that there are implications for central participation in a network that are in addition to those documented elsewhere (e.g., academic success (Saqr et al., 2020), development of MKT (Silverman, 2012)). Further, our findings extend research correlating centrality in discussion networks with persistence in college to the context of online mathematics teacher education. Establishing a research base that documents factors, conditions, and events that impact teachers' persistence in professional development can inform design and implementation strategies. For example, we plan to test a strategy for impacting teachers' persistence that includes increasing peripheral participants' betweenness centrality by prompting them to share connections they notice in colleagues' ideas on a discussion forum.

Our findings also showed that centrality was not correlated to persistence for cohort two. One explanation for this could be differences in the timeframes of workshop one. As noted above, cohort one participated in a 6-week version while cohort two participated in a 2-week version of workshop one. Our ongoing analysis indicates that the structure of cohort two's network was less reflective of a community than cohort one's network. Even though there was a range in centrality measures for cohort two, the accelerated timeframe may have reduced opportunities for teachers to engage deeply with their peers' resources; thus, impacting how they perceived the potential benefits of participation and perhaps their "sense of belonging" (Baumeister, & Leary, 1995). This opens up a question about how the length and quality of initial professional development experiences impact teachers' potential to persist in the professional development.

As the need remains for sustained and effective professional development that supports mathematics teachers in developing discourse-rich and student-centered instructional strategies, additional research is required to gain deeper insight into factors, events and conditions that impact teachers' persistence in professional development. One future area of inquiry that could extend this work might include investigating relationships between teachers' centrality in online discussions, individual attributes (i.e., gender, MKT, etc.), network structures (e.g., cliques (Joksimović et al., 2016)), and persistence. We are currently exploring statistical network models such as exponential random graph models to investigate these relationships (e.g., see Bjorklund & Daly, 2021; Lusher et al., 2013).

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