Investigating Dynamics to Understand Interactions in Professional Development Groups

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Abstract: In this study a dynamic systems approach and analyses is used to identify dynamics that constrained the collaboration of a group of teachers to complete a reform-oriented curriculum task in a professional development setting. A central goal was to identify challenges to achieving emic or self-organized structure necessary for sustaining innovative educational programs. The study found that a local social and emotional dynamic influenced the emergence of a strong global dynamic of social support that ultimately produced the contextual outcome of low productivity. The paper asserts that teachers need intentional training to gain skills for working autonomously. Helping teachers become aware of the dynamics needed for successful collaboration would assist in achieving self-organized participation. An important contribution of this study is the application of a dynamic systems lens, which enabled the location of levels of micro and macroscopic influences that can be used to inform future professional development activities.

Introduction

The research reported here follows on a series of studies that have investigated the complex or non-linear nature of teacher interactions in professional development activities (Yoon et al., 2010). Previous research has revealed differences in the way that teacher groups display more or less adaptive collaborative activity (e.g., Horn & Little, 2010) and how collective approaches in professional development influence teacher growth and student learning (Desimone, 2009). Some research has suggested that differences between how teacher groups function may be attributed to several variables which include a lack of understanding of how to self-organize effectively as a team (Main, in press). However, the general consensus in the literature about teacher collaborative groups is that we still know every little about how they operate and the interactional processes that lead to problem solving and decision making (Havnes, 2009; Meirink et al., 2007; Scribner et al., 2007). The often non-linear nature of team formation and development (Ito & Rotheridge, 2005) coupled with the need to promote collectivity suggests that investigating the interaction of teacher groups requires methods that can accommodate these characteristics and capture critical impacts on collaborative activities as they emerge. To date there appear to be few methodological tools that can do this systematically. Thus, in this small group case study, I use a dynamic systems approach as a methodological tool to investigate the interactions of six teachers as they collaborated to construct reform-oriented curricula. I wanted to examine the utility of this systematic process in revealing the complex nature of interactions that enabled or constrained self-organization. I was also interested in understanding the developmental dynamics that shaped the group's ability to accomplish a systemic reform task.

Dynamic Systems Approach to Understanding Group Activity

Dynamic systems are complex organizations of interacting parts that work together to give rise to patterns of behavior over time (Churchill, 2007). Through these lower level interactions that are initially unstable, more stable patterns emerge and solidify into attractor states that the entire system tends toward (Granic et al., 2007). For example, Martin et al. (2005) have studied how children's play partners, while initially variable, organize into coherent friendship clusters due to individual differences in personalities and other behavioral characteristics. While perturbations can shift the configuration of the system temporarily (e.g., a new person monopolizes a friend's attention), depending on the strength of the attractor (e.g., friendship bond), the system will form very stable behavioral states (e.g., friendship resumes). How attractor states form and settle over time are known as self-organization and emergence in dynamic systems and can be tracked over time to explain the evolution of system trajectories (Lewis, 2000; Steenbeek & van Geert, 2007; Thelen & Smith, 1994).

The self-organization or emic nature of dynamic systems aligns well with the local or peer-to-peer goal for our professional development activities. Methods for which to understand these dynamics also connect well with this study's focal interest in how teacher interactions can shape outcomes. For example, Farmer et al. (2007) and Lichtwarck-Aschoff et al. (2008) identify developmental factors that work together as a system of correlated constraints. They discuss how system components mutually influence each other and become aggregated in macroscopic patterns to constrain or control the entire system activity. A coherent model that categorizes such local and global dynamics with contextual outcomes can be found in Arrow et al. (2000) in which small groups are viewed as dynamic systems. The case study in the present research uses this model and defines local dynamics as rules of activity for parts of the system, i.e., the teachers, and global dynamics as rules

of activity for system-level properties that emerge out of local dynamics. These are the patterns of behavior or system attractors that stabilize in the professional development group and influence contextual outcomes.

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The study investigates the interactions among a group of six teachers who worked together for 10 months. The group was comprised of three males and three females from six different high schools in a large urban school district. Teaching experiences ranged from 5□26 years. Teachers taught across different science disciplines and all high-school grades. More details about selected participants follow. Teachers participated in a ten-day summer PD workshop in August of 2010 (50 hours), and then in monthly meetings from September 2010 □May 2011 (35 hours). Their task was to create a publishable high school science curriculum book using units they already constructed for a larger project on 21st century problem-based learning and digital participation. Teachers were selected due to their demonstrated commitment in the larger project, their pedagogical skills in delivering their curricular units, their perceived abilities for leadership, and their perceived ability to collaborate. Teachers were told that the project was ultimately aimed at producing curriculum that was vetted and constructed by teachers for teachers for implementation in real-world urban classrooms thereby increasing the potential that new teachers would be able to use the curriculum successfully. The goals of teacher ownership, collaboration and decision making were greatly emphasized and teachers were given the message that self-organization was a major expectation, i.e., that there would be little input from researchers as to how the book would be constructed.

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Data sources and analyses included: 1) Initial surveys of participant demographics that collected experiences and goals for participation; 2) Six individual interviews at the end of the summer workshop 2010; three individual interviews at the end of May 2011. Interview questions asked how participants felt about the collaborative effort, what their role in the book project was, and reasons for why particular project and group outcomes emerged; 3) Sixty hours of recordings from both the summer workshop and monthly sessions documenting group activities and dynamics; and 4) Five surveys of collaboration rankings during the summer workshop in which participants were asked to rank other members of the group from 1-5 in terms of who was the most central person in the collaboration task, a rank of 1 being most central. Initial surveys were used to establish an understanding of each participant□s unique set of qualities and experiences that potentially influenced local dynamics such as having less teaching experience than others in the group. Interviews and recordings of group meetings were qualitatively mined by the researcher and two doctoral research assistants to look for local and global dynamics and contextual outcomes as they emerged over time. To validate the findings, the global dynamics and contextual outcomes were reviewed with participants in the May 2011 interviews. For collaboration rankings, an in-degree score for each teacher was calculated from the average of teachers□collaboration rankings for each time sample. In-degree scores can be used to represent an actor□s prestige or status in a system (Wasserman & Faust, 1994). In this study, the in-degree score was used to determine who might have influence on group dynamics at particular points of the study. The lower the average number a teacher received, the higher the degree of centrality. A sample of the findings is presented below.

Resul□s

Local dynamics (rules of activity for the teachers): Table 1 shows the in-degree scores of the participants in the study. Participant trajectories illustrate who had influence in the system at specific points. Don ranked near the top or at the top during the first week of the workshop while Isabel□s ranking was at the middle or below. During the second week, Isabel and Don□s rankings switch on Day 7 where Isabel had the highest in-degree score. At the end on Day 9, Isabel returned to her normal middle spot while Don□s position fell to nearly the bottom.

Table 1: Teacher's in-degree scores based on a ranking of like-mindedness

Ranking	In-degree Score Day 1	In-degree Score Day 3	In-degree Score Day 5	In-degree Score Day 7	In-degree Score Day 9
1	Carol (1.8)	**Don (2.6)**	**Don (3.0)**	**Isabel (1.8)**	Bill **(1.8)**
2	**Don (2.0)**	Carol (3)	Bill **(3.0)**	Carol (2.3)	Carol (2.2)
3	**Isabel (3.0)**	Bill **(3.3)**	Carol (3.4)	**Don (3)**	**Isabel (2.4)**
4	Stan (4.3)	**Isabel (4.0)**	**Isabel (3.6)**	Bill **(3.3)**	Stan (4.2)
5	Shelley (4.4)	Stan (4.0)	Stan (4.2)	Shelley (5.6)	**Don (4.3)**
6	Bill **(4.5)**	Shelley (5.0)	Shelley (4.8)	Stan (5.6)	Shelley (5.5)

re ie o their ini i al alitie e erien e an oal or arti i ation hel to a e en e o the e tra e torie o er ti e a etaile in the ne t e tion. on a the ol e t tea her in the ro ho a e to tea hin a ter a erie o o in the or orate orl e a e he ante to a e a i eren e in o iety. i oal or arti i ation ere to hel other tea her eel o orta le ith ne e a o i al a roa he. t the ti e o the er or ho he a or in on a a ter e ree in a ily thera y an inten e to a e another areer han e ro tea hin. n the or ho inter ie he e ri e hi ontri tion a ee in thin li ht an o ial to en re that the ro ha n. e o ten i e the i i lt rea rati an o ial i e that i a te t ent an tea her li e in the i tri t. n ontra t a el a the yo n e t tea her in the ro ith i e year o e erien e. er oal or arti i ation in l e an intere t in ontri tin to ien e e ation an to i a t the ra ti e o other tea her y on tr tin oo rri la. She e re e an intere t in e ent ally oin a o torate in e ation. She ante to arti i ate in the er or ho to olla orate ith i erent tea her. n the ay 2011 inter ie he ai he elt that he ha any oo i ea to hare t i nt eel that he ha the a thority to h the in the ro.

Global dynamics (rules of activity for the group): o in e ti ate the lo al yna i that e er e at the y te le el or ho re or in ere ine to i enti y attern in ro interaction that ay ha e een in l en e y the a o e lo al tea her yna i . Sin e the ta re ire the to a e e i ion a o t ho the rri lar oo o l e on tr te the analy i on entrate on in tan e in the i to r e here the ro ha to a e a e i ion. ro thi analy i three lo al yna i e er e i.e. o ial ort anti or an on t ro the oat. i en e o the ir t yna i i re ente elo.

The social support dynamic: hi yna i a a o t ro e er ainin oral ort ro ea h other an harin e erien e a o t the hallen e they a e a tea her or in in a y n tional r an hool i tri t. on er onal yna i an oal ein ali ne ith o ial an e otional ort ontin ally in l en e other in the ro to arti i ate in o ial harin rather than o letin the rri l on tr tion. on al o ha a tron an or e l er onality hi h he i e iately e erte. he e yna i an e o er e in theollo in e er t o ay 1 i to r e. Be ore thi e er t the ro a a e to e in a in e i ion a o t hat a ti itie they ante to in l e in the rri l . Bill tarte on a line o i ion a o t ettin arent on oar. e tal e a o t ho o e o hi t ent ent ho e a ter an i a t l e o an tol their arent.

er t l t 2 2010 ay 1 ho r l l 10 03[1]

1.	Bill	So the arent ere intere te
2.	on	hat i a reat e o
3.	Bill	i ht. arent ere
4.	on	that really i.
5.	Bill	arent ere intere te in hat a oin on o that tol e ri ht then
6.		that the i ent ho e an tol their arent
.	on	C .
8.	Bill	ell e re oin to e oin thi. t a o ethin i erent an
.		n hen y arent a e in on arent ni ht ay yo no ell
10.		i yo r hil ren on t no e a tly hat iel they ant to o into
11.		thi ay e a iel that yo r hil ren o l o into
12.		o y ttin in a hoo ith yo r arent that a e the intere te hi h a e
13.		the hil ren a little ore intere te in hat oin on
14.	on	So i e are oin to o that
15.		at lea t no e an t ea or yo e a e yo are o t i e the hool i tri t 15.
16.	Carol	i ht
1 .	on	thin in a o t e ha e the ir t ee e ay an e ne ay
18.		((no in the ta le)) e re o or t o ay then e ha e o r ay an that
1 .		an that h r ay ni ht that a to hool ni ht. So i e re oin to o it
20.	Bill	ean that a ean
21.	on	ean it a oo i ea
22.	Bill	i ht an
23.	on	t e otta o it early.
24.	Bill	i ht e ha e to e ha e to o o ethin li e that early.
25.	on	Be a e e literally ha e
26.		6 ay ntil a to hool ni ht.

hen Stan e laine that he ontin e to ha e tro le ettin hi t ent to i n t y on ent or . ro there he tal e a o t ho hi tea hin ro ter ha al o han e i e ter hi h ro te Shelley to hare her o n i e ith the tea hin ro ter. By thi ti e the on er ation ha irale into one that o e a ay ro e i ion a in a o t hat a ti itie to in l e in the rri l . ro the i ro r e e er t the tone o on o ent ere a tionary e to the a t that tea her nee e to tay in line ith the i tri t often irrational e i ion(h a the ti in o a to hool ni ht). hi o ene the loor or Stan an Shelley to i their ro e ional i e to arner o ial ort ro the ro . hi lo al yna i o *social support* o en o inate the i ro r e thro ho t the or ho an in o ination ith other e er ent lo al yna i on traine the ro a ility to o lete the rri l on tr tion. hi tron attra tor a initiate an taine y on lo al yna i a e i en e ro the i ro r e an hi hi h e ree o entrality in the ir t ee. a el ho e lo al yna i re re ente ontri tion an olla oration rarely arti i ate in o ial harin . n the i ion he o en atte te to re ire t the ro to ar o in on the rri l on tr tion ta . e ite her e ort e eral e i ion a in e i o e a el initiate ere le t nre ol e. hen a e to re le t on the in o ro yna i that e er e o er the 10 onth olla oration rin the ay 2011 inter ie he ai the ro o iali e a lot an hy othe i e that thi yna i in art e er e e to the re earh a ilitator ina ility to ana e on yna i . t i ortant to note ro a le 1 that the ay a el ran e l in the in e ree ore o the er or ho (ay) the ro e t ent a reat eal o ti e in the ornin in ith the ro the li ite ti e they ha to ini h an r e the to or ore e i iently an to a e reater tri e in the re ainin art o the ee. o e er e to the ta ility o the tron o ial ort attra tor a el o ition ell a ain t o ay later (ay). he e yna i ltimately ro e t o onte t al o t o e i.e. a la o el or ani ation an in o lete rri l hi h a e the ro e t to all hort o it oal.

Discussion and Implications

Similar to previous studies (e.g., Havnes, 2009), this research investigated conversational processes that emerge in groups to understand the dynamics that impact collaboration (Scribner et al., 2007) and productivity. Using Arrow et al's (2000) framework the findings demonstrate how Don's local dynamics influenced the emergence of a strong global dynamic of social support that ultimately produced the contextual outcomes of the lack of self-organization and incomplete curriculum construction. By following the dynamics that emerged over time and by using in-degree rankings this method located potential source(s) of influence, evaluated the comparative strength of the influence and hypothesized some reasons why the influence persisted. Between the two focal teachers in this paper, Isabel who represented the dynamics of contribution and collaboration clearly had the disposition and goals that were ideal for participation. However, her local dynamics did not influence the group where Don's appeared to dominate. Differences between the two teachers in terms of their experience and personalities may have contributed to their abilities to influence the group. Another important contributor as revealed in Isabel's interview was the fact that teachers appeared to rely on the researchers to exert control, despite the strong emphasis on leadership, collaboration, teachers as decision makers, and ownership.

But what is the reason for why this group operated in the manner that it did and how can knowing about this help to achieve self-organization in teacher groups? The interactional patterns shown in the group's discourse can be explained through a dynamic systems lens. Initially, varying unstable local dynamics interacted and the confluence of variables gave rise to patterns of behavior over time (Churchill, 2007). Don's passionate personality coupled with the expectation of external control solidified into attractor states (e.g., the social support dynamic) that the entire system tended toward (Granic et al., 2007). Although perturbations (e.g., the PI urging completion) had a temporary effect, the strength of the social support attractor continued to win out. From this assessment, it seems that the perturbation needs to be stronger than the stable attractors the system settles into. Other implications pertain to creating professional development structures that simultaneously address the local dynamics and needs of teachers and goals of the project. We saw that teachers wanted social and emotional support of the collaborative group, but this function did not fulfill the curriculum construction activity. A collaborative teacher group should succeed on both professional and personal levels to ensure positive membership and productivity. Another implication of the findings is to provide opportunities for teachers to become skilled collaborators. Teachers need intentional training and modeling on collaboration to gain self-organization skills. This point supports assertions made by Main (in press) in that teachers may lack understanding of how to work effectively as a team. Helping teachers become aware of the dynamics needed for successful collaboration, as Scribner et al. (2007) suggests, would assist in achieving the goal of self-organized participation. In order to identify these dynamics, an important contribution of this study is the application of a dynamic systems approach and analysis that revealed local influences on global dynamics that can ultimately inform future professional development activities.

Endnotes

(□) Transcript convention used in excerpts follow the □efferson Transcription System

□□□start and end of overlapping speech	((laugh))□gestures or comments	(2)□seconds of pause in speech
Underlining□emphasis in speech	(.)□hearable micro pause	CAPS□ rise in volume

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