

Exploring the Operational Process of a Teacher Professional Learning Community Through the Lens of Activity Theory: A Chinese Perspective

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Adopting the perspective of activity theory, this research investigated the interactive core elements within a school as a teacher professional learning community (PLC), and analyzed the relationships between these factors and school innovation. The research was based on a qualitative case study over 3.5 years in a newly established private boarding school (School S) in western China. Semi-structured interviews, field documents, and classroom observations were employed to collect data. The research found that teachers played a major role in active interaction with other factors within the PLC. Updating teachers' knowledge and building school knowledge were the objects of the PLC, which motivated the learning activities in School S. There were four intermediary factors between the subjects and objects. Results also showed four interaction pathways within the school as a PLC, namely subject-tools-object, subject-rules-object, subject-community-object, and subject-division of labor-object. These findings indicate that a teacher PLC is a self-organizing learning activity system. The operation of PLCs has realized the transformation from a top-down model and bottom-up model to a middle-up-down

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interaction model in the school, thus stimulating organizational vitality and promoting organizational knowledge creation.

Keywords: teacher PLC; activity theory; interactive process; mainland China

The Need for Investigating the Operation of PLCs

In early 1990s, the concept of learning communities appeared in the literature of organizational theory. Over the last 30 years, we have been more convinced that knowledge acquisition within professional learning communities (PLCs) is vital to individuals and organizations, be it enterprises or schools. PLCs appeared to hold considerable promise for sustainable improvement in schools.

Now we believe that the knowledge gained by an individual, a group or an institution is an undeniable advantage in the workplace, especially in schools (Hargreaves & Shirley, 2012). Within the context of education, teachers as learning individuals represent the most valuable resources of the school community (Wenger, 1998). Understanding effective PLCs in schools, including their operation processes and improvement strategies, are research focuses in school innovation. Therefore, the PLC concept in this article describes not just individual teachers' professional learning, but also the professional learning within a community context to enhance school development as well as pupils' learning (Harris & Jones, 2010; Philpott & Oates, 2017).

Many studies have contributed to developing and synthesizing the key features and components of PLCs. The core elements of an effective PLC are: shared goals, cooperation activities, a focus on student learning, shared practices, and reflective conversation (Hallam, Smith, Hite, Hite, & Wilcox, 2015). Bolam, McMahon, Stoll, Thomas, and Wallance (2005) defined eight key characteristics of effective PLCs based on an extensive survey. Watson (2014) clustered these elements into three main aspects: shared values and vision, learning within the PLC, and community.

The most persuasive and popular point is that a successful PLC in a school has five fundamental attributes, namely: (a) supportive and shared leadership (Hallinger & Heck, 2010; Knapp, Copland, Honig, Plecki, & Portin, 2010; Kurland, Peretz, & Hertz-Lazarowitz, 2010; Leclerc, Moreau, Dumouchel, & Sallafranque-St-Louis, 2012; Linder, Post, & Calabrese, 2012); (b) shared values and goals (Barton & Stepanek, 2012; Doig & Groves, 2011; Philpott & Oates, 2017); (c) shared personal practices (Hunzicker, 2011; Sanchez, 2012; Wenger, McDermott, & Snyder, 2002); (d) collective learning and application

(Hargreaves, 2003; Hipp & Huffman, 2010); and (e) supportive conditions (Barton & Stepanek, 2012; DuFour, DuFour, & Eaker, 2008; Harris, Jones, & Huffman, 2018; Philpott & Oates, 2017).

Teacher professional learning communities (PLCs) as a strategic element (Harris & Jones, 2010) have to be adapted to maximize school effectiveness (Fullan, 2009; Harris et al., 2018) and school innovation in knowledge society (Hargreaves & Shirley, 2012; Harris, 2011). However, the attempts of schools to create PLCs usually fail (Sims & Penny, 2014), even though many studies have attempted to identify the characteristics of effective schools (Harris et al., 2018). Because many studies suggested that the school as a PLC is influenced by complex factors such as excessively strong subjects and group boundaries (Zheng, Zhang, & Wang, 2019), an overemphasis on uniformity (Kaster & Halber, 2006), restricted collective and individual autonomy (Harris & Jones, 2010), and vulnerable collegiality and collaboration (Hallam et al., 2015; Hargreaves, 1991). Nevertheless, teacher as active subject within PLC is widely considered an essential factor to improving schools or curriculum reform process. Goodwin (2012) found that teachers in PLCs are well-informed at the pedagogical level and trust each other; they are committed to continuing professional development (Timperley, 2011), and they also consider student learning as their key calling and share responsibility and support (Sims & Penny, 2014).

Besides, some researchers have paid attention to the interactive relationship of the core elements within PLCs (Baran & Cagiltay, 2010; Chen & Wang, 2015). Opfer, Pedder, and Lavicza (2011) illustrated that this process can be explained by a set of social relations which created the culture and shared responsibility for teacher learning, improved teachers' understanding of key pedagogical elements, and promoted the implementation of effective practices. Baran and Cagiltay (2010) developed four pathways of online communities according to the activity theory to further explore the interactive relationships. Besides, many researchers have paid attention to the important active role of teachers in the interactive process within teacher PLCs (Douglas, 2011; Saka, Southerland, & Brooks, 2009; Trust, 2017; Watson, 2014).

Moreover, the evolving process of PLCs also involves schools' incremental change from the initial stage to the implementation stage, and finally to the institutionalization stage (Fullan, 1985). PLCs can be directly affected not just by the external features of school organization (Barratt-Pugh, Zhao, Zhang, & Wang, 2019; Heggen, Raaen, & Thorsen, 2018; Wells & Feun, 2013), but also by the different leadership styles of principals, the distribution of authority, and the schools' resources and programs (Sargent, 2015).

However, the core elements in the operational process within teacher PLCs in schools have tended to be ignored. Such studies did not provide descriptive information of how teacher PLCs effectively operated in schools. In fact, this black box needs to be opened up in order to have a clearer view of the operating procedures and paths within PLCs in schools. Moreover, the interaction of these core elements in the operational process of teacher PLCs has not been considered in depth. Hallinger and Kulophas (2020) indicated that the internal operating mechanism was limited. The purpose of this study was therefore to uncover this sustaining innovation process of a school by exploring the interaction mechanism of the features within the PLC.

Activity Theory as a Theoretical Framework for Analysis

With the sociocultural turn in learning science in the 1990s, the learning community research fields were undergoing what was termed a “cultural turn” (Koschmann, 1999) or “sociocultural revolution” (Kelly, 2006; Levine, 2010), ushering in new theoretical frameworks and conceptual shifts which are commonly used to guide our empirical inquiry. The argument is that learning and knowledge building are regarded as inherently social (Aalst & Hill, 2006), and cultural activities and tools are regarded as integral to conceptual development (Levant, 2016).

PLCs are a central instructional structure based on the sociocultural perspective of learning. What is more, the sociocultural lens reveals the interaction relations of agencies within the communities based on the notions that learning is socially constructed, dependent upon interactions, and socially mediated (Moll, 2001; Vygotsky, 1986). This perspective is appropriate for studying individual teachers’ learning within the context of schools, and for studying school-level learning (Gallucci, Van Lare, Yoon, & Boatright, 2010; Goodwin, 2012).

This research aimed to identify the core elements in the operation of teacher PLCs in schools and to discover the interaction of these core elements in teacher PLC operational process. The authors employed the cultural historical activity theory (CHAT) as a theoretical framework. Activity theory offers conceptual tools that could be useful in studying ongoing PLCs (Sannino & Nocon, 2008). Activity theory is an especially relevant theory to use in this study because it allows for an understanding of how multiple elements interact with each other within PLCs in order to build shared knowledge for school innovation.

What is more, a strong hierarchical and collective culture of administration is commonly found in Asian countries (Arani, Fukaya, & Lassegard, 2010). In China, teaching research groups and lesson preparation groups have been implemented for over 50 years, representing a type of peer collaboration and collective inquiry of teaching aiming at improving classroom practices (Wang, 2015). Activity theory provides a theoretical account and set of tools for understanding “collective, and mediated human activity” (Engeström & Miettinen, 1999, p. 9). A fundamental insight of this body of theorizing is that all human activity is oriented toward producing either material or conceptual things.

Components of activity systems include the following (Engeström, 1987):

1. *Subject* is the doer of the action, the performer, the actor. The subject is usually an individual, but could be a group, depending on the level of analysis or the type of analysis being done.
2. *Object* is the true motive of activity. The object in activity theory is often conflated with the objective of the activity.
3. *Rules* can be written or unwritten, but they both constrain and justify action by the subjects.
4. *Community* is a nexus of interested parties — that is, stakeholders in the system. Alternatively, the community might be others who provide the context for the work being done by a subject (or subjects). The key is that there has to be some shared element that defines a community across the activity system.
5. *Division of labor* specifically addresses who can (or is expected) to do what. In every activity system, there evolves (or is created) a way of dividing up the labor so that the object can be worked on. Like rules, the division of labor constrains and justifies action.
6. *Tools* are also called mediating artifacts. They are not necessarily physical. They could be procedures. Instruments are the means by which the subject affects the object.
7. *Outcome* follows from the object and is closer to what most people think of as a goal or an objective. As a result of the activity system acting upon an object, there is an outcome. The outcome results from some transformation in the object.

Activity can also be understood in terms of the interaction or co-creation of multiple components of human activity, including rules, division of labor, community, and the artifacts (tools) that mediate a subject’s ability to achieve the object (or intended outcomes) of their activities (Engeström, 1999). In other words, activity theory has heuristic affordances for parsing activity into pieces, and seeing how these pieces interrelate, even if

all of these components are mutually constitutive. An activity analysis must consider these seven elements of activity. Every activity is in some sense unique, and not all elements will be key in every case. However, the authors believe that the benign interaction between those seven elements within PLCs is the key to any successful activity.

The affinity of PLCs to schools' sustaining innovation process and building shared knowledge indicates that the interaction process of activity system elements is significant. Engeström (1987) developed the activity theory from a philosophical and interdisciplinary theoretical framework for exploring the different forms of human activities to a methodology. It structured the description of the activity system, revealed the constituent elements of activity and the interactive relationship between those core elements. How those components interact with each other within PLCs in schools needs to be further explored. This study was informed by relevant literature, and sought to provide new insights into the interaction mechanism within PLCs in the context of mainland China.

In summary, activity theory can either bring one or multiple components of human activity into focus as critical contributors to what human beings can produce together. It has grown into a rich and sprawling set of ideas and approaches offering more affordances and insights. Enlightened by the activity theory, this study addressed the following two research questions: (a) What were the core elements in the operation of the PLC in the school? (b) How did these core elements interact in the PLC's operational process?

Methodology

The Case School and Participants

School S is located in City Y, Province N, in western China. It is a private boarding school. The school philosophy is to practice life-long development of education for students while respecting the variety of students' capabilities. Small-sized teaching is promoted in their recruitment strategies. The school began to enroll students on July 1, 2016. At present, the school has 67 classes with more than 2,100 students from ages 13–19, and 256 teaching staff with an average age of 32 years old.

The school has modern networked classrooms, campus network centers, and electronic reading rooms. The experimental building is equipped with specialized experimental equipment for physics, chemistry and biology. Each classroom in the teaching building has electronic whiteboard facilities and other audio-visual equipment.

After the 2020 College Entrance Examination, the students' ranking increased by 1,520 on average compared with their examination rankings before entering School S. The success of this newly established school has been applauded by local government officials, other school principals, and parents.

This study was primarily interested in the interaction process within the teacher PLC of School S and adopted a qualitative case study design (Creswell, 1994). Qualitative research methods and sources allow for understanding teachers' learning activities in collaborative school system and the changing process within the system. A case is a phenomenon of some sort occurring in a bounded context (Miles & Huberman, 1994). The case study is able to highlight and explain how the teachers interact with other components to achieve the subject goals in the PLC through the lens of activity theory. Therefore, the researchers aimed to present a detailed picture of the operational process within the teacher PLC based on the research questions.

The 16 focal interviewees listed in Table 1 made important contributions in the process of the teacher PLC constructing School S. The principal and vice principal were committed to classroom reform and school innovation. Five of them acted as subject team leaders to guide the teaching reform in School S.

Table 1: Summary of the 16 Focal Interviewees from School S

Name	Subject	Gender	Years of teaching experience	Education background	Position
Principal A	Math	Male	15	Doctoral degree	Principal
Principal B	Physics	Female	10	Doctoral degree	Vice principal
Teacher A	Math	Male	10	Bachelor degree	Subject team leader
Teacher A1	Math	Male	5	Master's degree	Teacher
Teacher A2	Math	Female	4	Master's degree	Teacher
Teacher B	English	Female	8	Master's degree	Subject team leader
Teacher B1	English	Female	3	Master's degree	Teacher
Teacher B2	English	Female	6	Master's degree	Teacher
Teacher C	Chemistry	Male	8	Bachelor degree	Subject team leader
Teacher C1	Chemistry	Female	3	Master's degree	Teacher
Teacher C2	Chemistry	Male	4	Bachelor degree	Teacher
Teacher D	Physics	Male	6	Bachelor degree	Subject team leader
Teacher D1	Physics	Male	7	Bachelor degree	Teacher
Teacher D2	Physics	Female	5	Master's degree	Teacher
Teacher E	Chinese	Female	9	Bachelor degree	Subject team leader
Teacher E1	Chinese	Male	3	Bachelor degree	Teacher

Data Collection

The research was a longitudinal case study with a qualitative research paradigm employed to collect data over a period of 3.5 years from December 2016 to July 2020. Descriptive case study (Yin, 2003) was used to disclose the interaction process within the teacher PLC. This case study had multiple data sources and focused on understanding the dynamic interaction process within the teacher PLC. The data for this study included semi-structured interviews (each 45–60 minutes) of teachers, focus group discussions, visual documents, and field classroom observations. The data were triangulated (Denzin, 1978) with textual, visual, and verbal documents. These strategies were chosen to improve the understanding of teachers' learning process and its relevant factors within the teacher PLC of School S.

The total dataset included teacher interview data, 351 photos with elicitations, 32 videos, 10 field visits, 12 audio recordings of focus group discussions, 10 semi-structured interviews (Patton, 2002), and 32,000 Chinese words of project documents, lesson plans, and monthly and weekly meeting notes.

Data Analysis

Both the principal's and teachers' conversations in this study were conducted in Mandarin. Audio recordings of focus group discussions and semi-structured interviews were transcribed with the assistance of an external transcribing agency in China. The transcriptions were then reviewed and edited by the research team.

In accordance with the work of Krippendorff (2012) and Gee (2011), the data were subjected to textual and discourse analyses with two rounds of coding. Analytic induction began by sorting the data into categories based on the conceptual framework utilized in activity theory: subjects, objects, rules, communities, division of labor, tools, and outcomes (Engeström & Miettinen, 1999). In essence, the preliminary categories guided our work to help generate a great many codes within each category.

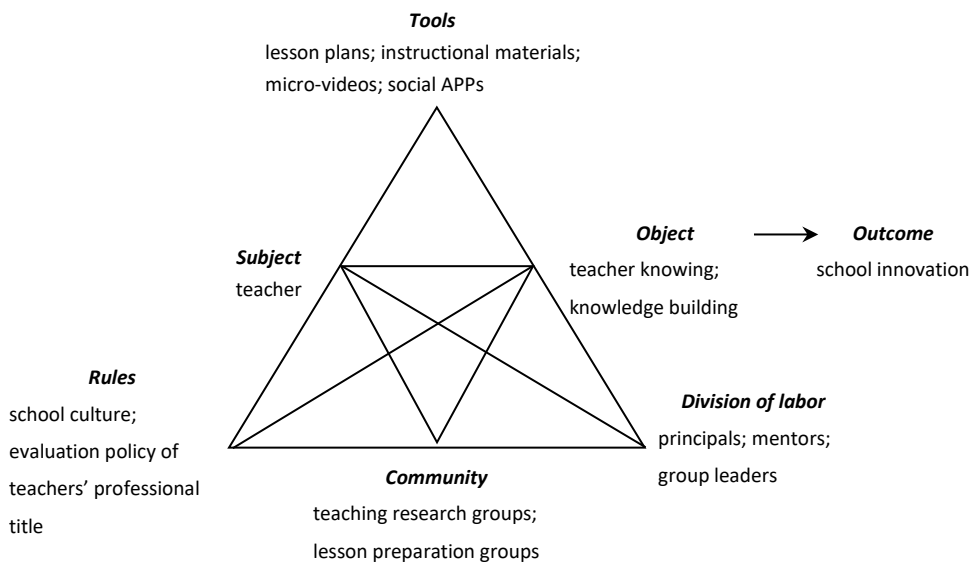
The researchers then explored data within each of these broad categories to develop a thick and rich understanding of what those concepts meant in the specific case (Bogdan & Biklen, 2006). Therefore, in analyzing the data collected in this study, it was important to produce thick descriptions (Geertz, 2008) of the interaction process within the teacher PLC of School S.

Furthermore, the researchers sought to understand how the teacher subjects interacted with other mediating elements to achieve the objects in the cultural and historical background, as explained by the activity theory. Gee’s (2011) big “D” discourse tool contends that a person conveys his or her identity through ways of acting, interacting, believing, valuing, dressing, and using various objects, tools, and technologies. In this study, the big “D” discourse tool was applied to analyze the collected data.

Findings

The purpose of this study was to identify core factors that influence the operational process of a school as a PLC and to analyze the links between the factors and knowledge building. Initially, the researchers will describe the factors relevant to the school’s innovation as a PLC. Subsequently, the researchers discovered the interaction relationship between those factors within the teacher PLC. Figure 1 shows the interactive relationships of factors within a PLC.

Figure 1. Interactive Relationship of Factors Within a PLC Under Activity Theory



Core Elements in the Operational Process Within the School PLC

Subject: Teacher as agent

From the perspective of activity theory, teachers as agents play an important role within the PLC of a school. The exertion of teachers' subjectivity and motivation is a prerequisite for positive interactions within the PLC. Teachers' subjectivity was manifested in the following three aspects.

First, teachers are the class decision-makers. In the institutionalized environment, the subjectivity is mainly reflected in teachers' decision-making in the classroom. Teachers' capability to integrate various elements within the PLC of School S and to make timely, optimal and instructional decisions was directly related to the efficiency of each lesson.

Second, teachers are teaching researchers. The research of teachers based on the classroom reform was the essence of the PLC in School S. On the one hand, rules and regulations were established to encourage each teacher to conduct teaching research. On the other hand, teachers were actively encouraged to set up research projects based on their own interests in collaboration with university researchers.

Third, teachers are reflective practitioners. Reflective practice is having a dialogue between teachers' pedagogical beliefs and factors within the PLC. Forming a teacher PLC in School S from the perspective of activity theory has been a continuous process of action and reflection, during which teachers as professionals consciously performed new real-time actions in response to the new experiences they encounter. This led to a new spiral of action and reflection within the PLC.

Object: Teacher knowing and knowledge building

A school is an organization that not only transfers knowledge but also constantly generates knowledge. Analyzing the operation and development process of a PLC is helpful for parsing the process of producing knowledge in the school. Therefore, the knowledge generated in School S was dynamically created by the social interaction of the elements within the PLC. Furthermore, the knowledge generation in the school was driven not only by the teachers, but also by the interactions among core factors within the PLC of the school.

The knowledge production comprises two levels: teachers' personal knowing and school knowledge building. A school as a PLC provides legitimacy for teachers' learning in the workplace. The teachers' formal and informal learning in the workplace is the process of

sharing teachers' ideas, experiences, and behaviors with peers. What is more, shared goals, supportive leadership, and shared structures within the PLC guarantee and support teacher learning, and offer identity and a sense of belonging for teachers.

The ultimate goal of teachers' personal knowing is for school knowledge building, which ultimately leads to reform and change in the school. In this process, the interaction among teacher peers and teachers with other elements within the PLC is the movement process of school knowledge building.

Rules: School culture and evaluation policy of teachers' professional title

School culture is the carrier of the operational process of a PLC. In this study, the researchers focused on how the implicit school culture influenced teachers' interaction behavior within the PLC of School S. Teachers, as the subject of the school culture, were the dynamic factors in the formation of the school culture. Besides, the culture of School S stipulated the rules and norms of teachers' participation in learning activities. Thus, the key factor in effectively running the teacher PLC was a value system and learning belief embodied in the implicit school culture.

Moreover, the policy of teachers' professional title evaluation and employment has a profound impact on teachers' classroom decisions and interactions within a PLC in mainland China. Promotion of the teacher's professional title is of great concern to all teachers because it is related to their self-fulfillment, career development, and salary. How to balance the current utilitarian evaluation criteria (only based on student examination scores) and achieve the goal of the PLC was an existing paradox in the formation and development of the PLC of School S.

Community: Teaching research groups and lesson preparation groups

Teacher learning styles embodied in the teaching research groups and lesson preparation groups were major features in the formation of the teacher PLC of School S. The system of the teaching research groups and lesson preparation groups based on subject, grade, and project has been very mature in schools in mainland China. From the perspective of activity theory, the interaction of the elements within the teacher PLC was beneficial for stimulating the organizational dynamic of those two types of teaching organization. It also provided a platform for teacher professional development and school innovation.

Cooperation was the main characteristic of the teacher PLC. However, the connotation of the PLC was not only limited to teachers' cooperation, but also teacher peers' debating, compromising and appreciating in the teaching research groups and lesson preparation groups. It was a process of negotiation of meaning experienced by teachers within the interaction process of the PLC which included rules, tools, division of labor, goals, and other factors in School S.

Division of labor: Principals, mentors, and group leaders

Division of labor is an important mediating role in the teacher PLC. The specific division of labor was formed not only by the top-down institution, but also by negotiation between the teachers in School S. Community members such as principals, mentors and group leaders with diverse responsibilities and obligations had different influences on the school as a PLC.

In the reforming context of the school, principals as leaders are irreplaceable and vital in shaping the vision of the teacher PLC, making decisions, and building the school culture. Hence how the principal's leadership operates in a PLC needs further exploration. Distributed leadership theory provides a well-recognized approach to answering this question which has multi-directional, dynamic and fluid properties. It was suggested that the principal as a leader practices not as a single individual, but rather as multiple members who share a common vision and collective work dynamically depending on the individual's characteristics and abilities, tasks and contexts.

Teaching research groups and lesson preparation groups were formal organizations established by teachers of a certain subject. Group leaders were usually the subject leader. They were the core figures in School S as a PLC. Besides, apprenticeship was used to train novice teachers in School S. The mentors were offered opportunities to observe classrooms and to reflect on teaching processes. They also helped novices to solve problems encountered in their classrooms.

Tools: Lesson plans, instructional materials, micro-videos, and social media applications

Tools used by subjects transforming objects into outcomes are the artifacts in an activity system. As intermediaries between subject and object, tools can be dynamically

modified, optimized, and developed by subjects, while they can reshape the methods of teachers' learning progress and practice.

According to the usages and purposes of the tools, within the teacher PLC, they can be divided into two categories: productive tools and communicative tools. Teachers of School S used productive tools such as lesson plans, instructional materials and instructional micro-videos to improve their teaching. They interacted with their peers and other elements of the PLC through communicative tools such as computers, whiteboards, various social networking software and teaching applications.

Outcomes: School innovation

Organizations, including school organizations, are combinations of a series of processes (Fishman, Davis, & Chen, 2014; Fullan, 2007). When a school is regarded as a PLC, the school innovation is also a series of reforms of the interaction relationships and interaction paths within the PLC.

The successful organization reform in School S was based on teachers' active participation. Attitudes and behaviors of the stakeholders directly affected the achievement of school innovation goals. The pivotal point of school innovation is whether the interaction between factors within the PLC can break through the "top-down" and "bottom-up" activity path to the "middle-up-down synergy" model. Teachers, as the subjects of the teacher PLC, achieved the goals of PLC through the four mediating factors in School S: tools, rules, community, and division of labor. The interaction process between the teacher and these mediating factors led to the development of the PLC; in other words, it resulted in school innovation.

The Four Interactive Paths Within the School as Teacher PLCs

From the perspective of activity theory, the essence of a school as PLC is reflected by the subject-producing activities. There are four interactive paths from subject to object in which the teacher as subject participated in learning activities and interacted with other core elements to achieve the school organizational goals.

Subject-tools-object

One of the most promising elements within the activity theory for making sense of

teachers' collaborative work comprised the role of tools within the PLC of School S. Reflecting its roots in Vygotsky's thinking, activity theory conceptualizes tools as material or mental objects that mediate learning; they both facilitate and constrain what individuals and groups of teachers do together. Using tools originated from others also showed how history and culture come to shape individual consciousness and the nature of the collective activity.

Focusing only on tools, just one element of the activity theory, can illuminate the affordances of physical technologies, such as the use of videos or the lesson plans and other instructional materials in a flipped classroom in School S:

Our school has its own library stocked with many books. Journals are also subscribed to every year. The school also provides computers for teachers and a pad for each student. (principal A-interview tape 2)

Besides, the flipped classroom implemented in School S has prompted teachers to integrate information technology into their classrooms. During the interaction process between teachers and information technology, lesson plans and instructional videos from the Internet, they could actively construct new knowing:

We prepared our lesson plans with colleagues and used them in the flipped classroom. We also learned to find valued instructional materials and videos on the Internet. Some teachers even recorded their own videos for classroom reform. We also shared them with colleagues. We really learned a lot in this process. (teacher B-interview tape7)

Besides, the teachers were trained to use the whiteboard, geometric drawing boards, and other such software provided by the school, which were really helpful. (teacher C-interview tape 12)

Furthermore, the teachers were required to update their educational theory knowledge, practical knowledge and ability structures in the process of classroom reform. This brought about a change in the teachers' learning beliefs, learning styles and attitudes which led to knowledge construction at the school level. Therefore, the updating and developing of teacher knowledge, in turn, enhanced teacher knowing. It has formed a well-conditioned circle within the subject-tools-object path.

Subject-rules-object

School culture was not the expressly stated shared values, traditional habits, behavioral norms and regulations gradually developed by principals, teachers and other staff in the PLC of School S. The implicit school culture restricted the thinking mode and behaviors of colleagues in school. The school culture of School S was formed by the interaction between teachers and other components within the PLC:

Our school is a newly built school. Teachers come from all over the country and are very young. The relationship between the colleagues is very harmonious, especially within the lesson preparation groups. (principal B-interview tape 8)

I really like to work here, although we all open up our classrooms every day, which is also stressful. We also need to attend seminars and take notes every week. But we are all used to doing so and really learn something in this process. (teacher C2-interview tape 12)

What is more, teachers' professional title is divided into four grades from high to low in mainland China: senior, level 1, level 2, and level 3. There has been an obstacle of structural imbalance in the implementation of teachers' professional title evaluation policy, and the same goes for School S. However, teachers in School S were more focused on the flipped classroom reform in the PLC. The positive interaction relationship within the teacher PLC motivated teachers' teaching enthusiasm and interest. The teachers could also treat and handle the professional title employment rationally:

Inevitably, we are all under pressure of the competition for titles. But I believe the purpose of teaching is improving students' achievement and developing students' ability. So, I am not worried about that for now. I am more concerned about how to improve teaching efficiency. (teacher D-interview tape7)

Subject-community-object

Activity theory has been used to conceptualize the communities of the teaching research groups and lesson preparation groups in School S. These groups were the main institutionalized organizations for implementing classroom reform; they were stable secondary communities in School S. Activity theory can help us to explore whether and how learning is fostered by teachers' active participation in groups which allows them to work

with and learn from their peers in the process of doing something worthwhile (Levant, 2016):

We are all joking that our teachers in the lesson preparation groups are a family, because we all observe and evaluate each other's classrooms and help each other to improve our lesson plans. (teacher A-interview tape 1)

Even though we prepare lesson plans together, we don't expect our lesson plans to be exactly the same. We also discuss and debate with each other. In this process, we also learn from each other. Besides the principals are supportive. (teacher A2-interview tape 6)

The division of labor between members of the PLC was implemented by preparing lessons, giving classes, presenting lesson plans, and reviewing classrooms. The regular learning activities held every week in groups gradually formed a teacher learning and teaching culture which has strengthened the cohesion of teachers within the PLC of School S:

School S has gradually formed norms of teaching research and lesson preparation activities which are approved and completed voluntarily each week. Besides, School S has observation and evaluation classroom activities every working day. Therefore, teachers are getting used to opening up their classroom. This is difficult in many schools in the context of mainland China. (observation note 14-researcher)

Through regular seminars and demonstrations organized by the teaching research groups based on subjects, a competitive atmosphere gradually developed among those groups, which virtually strengthened communication among the groups and cohesion among teachers within the groups:

Our school set up the teacher research center last year just like universities, in which teachers can apply for research projects. Each program received 30,000 to 50,000 yuan from the school. We happen to do research together and solve problems in teaching reform. (teacher B-interview tape 9)

The teachers were encouraged to carry out research projects using the teaching research groups and lesson preparation groups as a unit. It was helpful to improve their educational

research ability and also conducive to classroom reform. Teachers' individual professional development laid a solid foundation for innovation of School S.

Subject-division of labor-object

In this interaction pathway, the principals played an important role in the school innovation which broke down the division of institutionalized labor in School S. The leadership style of the principal has changed from a dictatorial and individual decision maker to an interdependent and collaborative interactor leader. In this process, the principal's leadership was becoming a central force in teacher PLC development and school knowledge building:

The success of the flipped classroom implementation depends mainly on the support of our principals. The vice principal Liu, in particular, has participated in our seminar every week and discussed how to improve the teaching. (teacher E-interview tape 14)

The observation and evaluation of classroom policy was made for opening up the classrooms to each other in School S. This schedule was the regular teacher learning activities within the PLC, and it has gradually become a significant tool for improving the instructional design and implementation:

The principals will force you to reform the classes in our school. The principals with other teachers will attend my class every week. After class, we will hold a classroom analysis meeting to find out what is needed to improve and discuss the solutions together. Next time, they will focus on checking whether you have made a change and how it is working. I have to admit that this process is very stressful, but I've certainly learned a lot and made great progress. (teacher D-interview tape 3)

The principals of School S had a transformational leadership style which connected the horizontal and vertical structural relationships within the PLC. They tried to shape School S as a PLC, turning the school from a working space to a professional learning field in which teachers performing different roles such as mentors and group leaders were responsible and conscientious:

More of our observation and assessment classroom activities are conducted within teaching research groups and lesson preparation groups. There is a clear division of labor between the group leader and members. (teacher E-interview tape 4)

We implement the apprenticeship system within the lesson preparation groups. Experienced teachers as mentors help novice teachers to improve their classes. (teacher A2-interview tape 11)

In this interaction pathway, the principals and teachers cultivated a shared value vision of School S as a PLC. The school had clear work tasks and schedules for teachers, establishing a trusting relationship between teachers, clearly defining the supervisory and cooperative relationship between different types of labor, and creating a competitive and mutual assistance learning culture. Hence, positive interactions within the subject-division of the labor-object pathway contributed to the outcomes of the PLC of School S.

Discussion

School as a PLC is a Self-organizing Learning Activity System

Activities and the activity system are the analyzing units of the activity theory lens (Daniels, 2004; Young, 2007). The activity system describes the relationship of the interactive components (subjects, objects, rules, communities, tools, and division of labor) in teacher learning activities in which the activity structure is a profound analysis dimension. The teacher learning activity structure can be understood at practicum levels which include learning activities, learning action and operational behaviors of transforming the object.

The study found that teachers, as the subject of learning activities, initiated and led the goals of the learning activities. Although teachers as learning subjects achieved the objectives through the intermediary factors such as tools, rules, community and division of labor from the perspective of activity theory, they were in turn deeply influenced by those factors. It was therefore an interactive process in the school as a PLC. However, the research revealed that the exertion of teachers' subjectivity was pivotal to the benign interactive relationship between the teacher and other elements within the PLC of the school.

According to Vygotsky (1986) and Engeström (1987, 1999), an activity is a process in which the subject is driven to the object under a certain purpose, and transforms the object into the outcomes of the activity system. Activities in the PLC of School S had an

object-oriented ideology, and the activities of the teacher PLC were goal-directed by the object of the PLC. Besides, teacher PLC is composed of a group of individuals who share common teaching beliefs and understandings, pursue common learning goals, and conduct classroom practices through cooperation and negotiation with each other (Thornburg & Mungai, 2011). The characteristics of the teacher PLC were particularly obvious in School S. Hence, the interaction process between the teacher and the elements within the PLC was a proactive, purposeful, and self-organizing learning activity process.

From the perspective of activity theory, teachers' learning activity is a process in which teachers participate in classroom practice and interact with colleagues and social contexts (Engeström & Miettinen, 1999). This study found that the levels of teacher learning activities in School S were a multipath dynamic process, and the four main interactive paths were subject-tools-object, subject-rules-object, subject-community-object, and subject-division of labor-object.

What is more, teacher learning activities within the PLC occurred not only between individual teachers but also between individuals and formal organizations in School S, such as the teaching research groups and lesson preparation groups. There are two dimensions of learning activities: individual learning and collective learning. Correspondingly teacher individual learning and school organizational learning are a process of knowing and knowledge building by intermediary factors within the teacher PLC (Prytula, 2012). Therefore, when exploring the interaction relationship within the teacher PLC, researchers should not only consider the activities of teachers' individual learning, but also focus on the social culture and historical background of the interaction process, as well as the intermediary factors used by members of the PLC in school.

Transformation From the Top-down Model and Bottom-up Model to the Middle-up-down Interactive Model

A teacher PLC, as an organizational system, has the same characteristics and performances of organization innovation. The outcomes of PLC activities are achieved by transforming the object into the outcome which can be material or conceptual, or even cultural (Vygotsky, 1986; Wenger, 1998). The four interactive pathways within the PLC can be divided into three models: top-down, bottom-up, and middle-up-down models (Nonaka, 1988). The study found that the transformation from the top-down model and bottom-up model to the middle-up-down interactive model has been realized in School S in mainland China.

The top-down model belongs to the classic hierarchical management paradigm in which the superior issues an instruction and makes plans for school reform. This model is popular in schools with hierarchical management systems in the context of mainland China. It affects the interactive relationship between teachers and other components of the PLC. The interactive principle of the top-down model is from the general principle to a specific application.

In the bottom-up model, teachers obtain the authorization from their superior and make their own decision of school reform in which the knowing and knowledge building are created by the middle- and lower-level staff in the school. However, teachers and principals act independently and lack adequate communication with each other. Besides, the interaction between teachers and core elements within the PLC is insufficient in both the horizontal and vertical dimensions for knowledge building (Wenger et al., 2002). However, sufficient interaction between teacher subject and core elements within the PLC is the key to school innovation.

Furthermore, distributed leadership is the main feature of the middle-up-down model (Harris, 2014; Nonaka, 1988, 1991). Teachers are encouraged to participate in the school decision-making process, and they take an active part in school reform based on power decentralization. It is easier to reach an agreement between teachers and school leaders within a PLC (Hairon & Goh, 2018). Therefore, the middle-up-down model is the fittest model for school innovation, as PLC members are the important interactors at both the vertical and horizontal levels of the school. School S is a newly established private school where the interaction relationship between teachers and principals is characterized by distributed leadership. The process of forming a PLC in School S may be easier than changing an already stable PLC in public schools in the context of mainland China which is more influenced by bureaucratic administrative leadership.

The feature of the middle-up-down interactive model is to maximize the interaction and cooperation between the teachers and the core elements within the PLC of the school. Therefore, the interaction relationship in the middle-up-down school organization structure is flexible, adaptable, and dynamic. It is the best model to stimulate organizational vitality and promote organizational knowledge creation. As a result, it is possible to truly face the challenge of how to create a school as a PLC (Hargreaves & Fullan, 2012; Senge, 1990).

Finally, it should be emphasized that these three models are not separate from each other. The school innovation depends on whether the three models can be used flexibly and

effectively; that is, the most appropriate model can be chosen according to the context of the learning activities within the PLC.

Conclusions, limitations, and implications

Teachers' learning activities and the activity system itself are constantly developing and changing, while internal contradiction between core elements are the driving force of teacher PLC development (Marwan & Sweeney, 2019). Therefore, the researchers use contradictions within the activity system to influence or promote the development of the teacher PLC. Many studies show that contradictions mainly exist in the interaction process of core elements within the teacher PLC (Leclerc et al., 2012; Rahman, 2011; Song & Choi, 2017).

The thrust of activity theory is that activities take place in the social system composed of subjects and objects. When analyzing the interaction relationship within the teacher PLC, the learning activities of teachers in the specific historical and cultural context can also be explored (Peim, 2009; Senge, 1990). What is more, activity theory is an intermediary action theory. It is therefore more pertinent and relevant for responding to the research questions of this study.

Further research is needed to explore the interaction relationship between teacher subjects and core factors within PLCs to uncover teacher knowledge building and school innovation processes in the context of mainland China. Researchers can use activity theory as a scheme to guide practice for improving the teacher PLC and school innovation in mainland China. Besides, activity theory is usually regarded as the origin of constructivism with abundant thoughts of the constructivist theory. Thus, the knowledge building of a PLC is not just an epistemological tendency but is more of an attempt to uncover the role of active builders of knowledge in the process of school innovation.

Meanwhile, this study has some limitations in its case selection and data collection and needs to be complemented by future research. This study selected a private middle school as the case school of the qualitative study. The finding showed a relatively benign interactive relationship within the school as the teacher PLC and also revealed the transformation of the interactive model. Although the interactive process in public school and private school have many similarities, there are still some differences under the school hierarchical management system in mainland China. The universality of the study result could be stronger if the study

includes cases of the public middle school. In addition, there is still potential bias in the data collection because of the researchers' positionality, though several measures had been taken.

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活動理論視角下教師專業學習社群運行過程探究：來自中國的經驗

楊鑫、鄭鑫

摘要

在活動理論視角下，本研究探究了學校作為教師專業學習社群，其內部各要素的互動過程，並分析了教師專業學習社群內部互動路徑與學校變革之間的關係。本研究歷時三年半，以中國西部一所私立中學為質性個案，採用了半結構式訪談、課堂觀察、實地文件等方法收集研究資料。研究結果顯示，教師身為主體要素在專業社群內部互動中發揮主體作用，目標是實現教師知識的更新和學校組織知識的建構。學校作為專業學習社群，其內部主體與客體之間有四條互動路徑，分別是「主體—工具—客體」、「主體—規則—客體」、「主體—社群—客體」和「主體—分工—客體」。研究還發現教師專業學習社群是一個自組織的學習活動系統，其內部各要素之間的良性互動實現了從自上而下模式、自下而上模式到中上下模式的轉變，從而增進組織活力和組織知識創新。

關鍵詞：教師專業學習社群；活動理論；互動過程；中國大陸

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