Activity theory as a Lens for the Heterogeneous Triad's Interactions in the Flipped Classroom

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Abstract: **In recent years, more attention has been paid to perceptions of teachers and students over the flipped classroom, learners' motivation, and academic achievement in existing studies. Little literature has closely observed interactions in the flipped classroom from the cognitive perspective. This study was intended to illustrate that the in-class collaborative learning can be conceived as a systematic activity as well as a collective activity consisting of separate actions in the flipped classroom. In light of the activity theory, tensions were observed among constituents of an activity such as subject, tools, community, division of labor and so on. A pre-experiment was administered in this study, selecting one lesson of 7th grade Information Technology Course as learning contents in the flipped classroom. As a case, one triad was screened as subjects in this study, who was composed of high, medium and low achievers in terms of the ICT literacy. It was found that such a triad with different levels of students smoothly interacts each other. Once they were confronted with secondary contradictions, they would overcome those tensions by co-regulation of each other's cognition. This study provides a new avenue for scholars to scrutinize interactions in classroom and enlightens how to enhance cognitive regulations for relieving tensions among elements of a systematic activity.**

Keywords: Activity theory, Cognitive regulation, Contradictions, Flipped classroom, Interactions

INTRODUCTION

In the past decade, K12 education in China has administered pedagogical reforms in the classroom, especially taking more interest in the flipped learning. Against the setting of the flipped learning, instructors are challenged by increasingly developing ICT and overwhelmed by substantial preparations of pre-class micro-lesson videos with effective guidance, in-class active learning activities and after-class online interactions (Abdulrahman & Al, 2015; Early, 2016). Up to now, in China more attention has been paid to producing pre-class micro-lesson videos instead of effective tactics engaging students in active learning activities (Blau & Shamir-Inbal, 2017; Kim, Kim, Khera, & Getman, 2014). Besides, flipped learning has been widely applied into various courses, such as statistics, chemistry, English, nursing, engineering, pharmacy and mathematics (Davies et al., 2013; Fautch, 2015; Hung, 2015; Mason, Shuman, & Cook, 2013; Missildine, Fountain, Summers, & Gosselin, 2013; Schultz, Duffield, Rasmuseen, & Wageman, 2014; Wilson, 2013). Those studies predominately focused on perceptions of teachers and students over the flipped classroom, academic achievement, and motivation. Whereas, few qualitative studies were administered about cognitive regulations during interactions in the flipped classroom. Most of previous studies on classroom interactions adopted Flanders' Interaction Analysis System as their methodology (Jungermann, 1981; Roland, 1983; Schempp et al., 2004), which in fact analyzes interactions from behavior instead of cognition. Recently, cognitive regulations in class have been regarded as an essential factor affecting effective learning (De Backer, Van Keer, & Valcke, 2015; Hayes, Smith, & Shea, 2015; Iiskala, Volet, Lehtinen, & Vauras, 2015; Järvelä, Malmberg, & Koivuniemi, 2016; Michailidis, Kapravelos, & Tsiatsos, 2018). In this study, cognitive regulations involve regulation of one's own, other's cognition and group awareness, in which planning, judgment, monitoring, control and evaluation are engaged in in-class collaborative learning of the flipped classroom (Malmberg, Järvelä, & Järvenoja, 2017).

As well, most of existing studies recognized classroom interactions as separate actions instead of

as a systematic activity (Duschl & Osborne, 2002; Jiménez-Aleixandre, 2008; Manz, 2014). Recently though classroom interaction as a systematic activity has been attended by scholars, it has not been studied much yet (Lazarou, Sutherland, & Erduran, 2016). Hence, this study takes more interested in cognitive regulations as a systematic activity in the flipped classroom. It aims to examine contradictions among components of an activity during cognitive regulations. In light of Bergmann and Sams' instructional design principles on in-class active activities like inquiry learning, problem-based learning and peer collaboration (Danker, 2015), this study draws upon peer collaboration as an in-class active learning activity. To know about the contradictions or tensions in classroom interaction, this study picks up one heterogeneous triad as samples to explore two questions as following:

1) What kind of cognitive regulations occur in the observed triad?

2) What kind of contradictions come out during cognitive regulation?

LITERATURE REVIEW

Flipped classroom

Compared to the traditional classroom, the flipped classroom reverses the knowledge delivery sequence in which the basic knowledge is transferred outside the classroom, higher-order thinking is reinforced by means of peer-to-peer and peer-to-teacher interactions in class (Hwang & Lai, 2017). In class, active learning activities are enhanced like problem-based learning, project-based learning, inquiry learning, collaborative learning and etc. to improve students' engagement and develop their critical thinking skills (Bergmann & Sams, 2014, 2015). In the flipped classroom, interactions play an important role in facilitating higher-order thinking among students, teacher and media (Sun, Xie, & Anderman, 2018).

Cognitive regulation in collaborative learning

Järvelä and Hadwin (2013) examined the role of regulatory processes in collaborative learning and introduced three types of cognitive regulation helpful for successful collaboration, i.e. self-regulation, co-regulation and socially shared regulation. Self-regulation refers to as regulation of one' own cognition, co-regulation as regulation of each other's cognition, and socially shared regulation as regulation of cognition about collective activity or task steering the task progress. In addition, from the perspective of cognition, Iiskala et al. (2011, 2015) claimed that the socially shared metacognitive regulation assumes an important role in collaborative learning. Socially shared metacognitive regulation refers to participants' goal-directed, consensual and complementary regulation of joint cognitive processes in the collaborative learning context (Iiskala, Vauras, & Lehtinen, 2004; Iiskala, Vauras, Lehtinen, & Salonen, 2011; Iiskala, Volet, Lehtinen, & Vauras, 2015). Meanwhile, Levine (2018) also reviewed the role of socially-shared cognition in small groups during problem-solving and decision-making, in which regulation of cognition is involved. Seen from the previous research, it was found that cognitive regulation can be conceived as an important role mediating effectiveness of collaborative learning. In this study, cognitive regulation is classified into self-regulation, co-regulation and socially shared regulation.

The cultural-historical activity theory (CHAT)

The cultural-historical activity theory(CHAT) (Engeström, 1987) emphasizes internal tensions and contradictions within and among components of a human activity which result in transitions and transformation of knowledge (Koszalka & Wu, 2004). The basic activity (Engeström, 1987) is composed of elements such as subject, object, tools, rules, community, division of labor and outcome. See Figure 1.

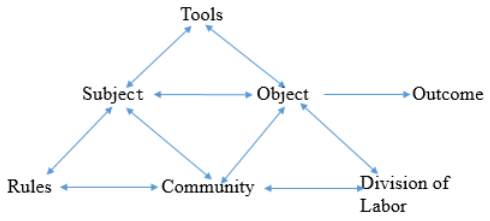

Figure 1. The basic frame of an activity system

The object is the motive and driving force of an activity. The subject is individual or group. Rules refer to norms and conventions ensuring shared responsibility and cooperation between the participants. The division of labor is regarded as organization of processes related to the goal. The community functions as a social group and mediates the interaction between the subject and the rules or the division of labor or the object. The outcome is the intended goals of the activity (Barab, Evans, & Baek, 2004). Generally, an activity system has four levels of contradictions. Primary contradiction exists within each node as Figure 1. Secondary contradiction arises between the constituent nodes. Tertiary contradiction occurs between the object/motive of the current activity and the object/motive of a culturally more advanced activity. Quaternary contradiction comes up between the current activity and adjacent activities from each node (Barab, Evans, & Baek, 2004). In this study, primary contradictions and secondary contradictions are underlined to observe one triad's interactions during collaboration.

METHODOLOGY

Participants

Although in a middle school 56 seventh grade students as participants took the ICT class in the form of flipped learning, in this study only one heterogeneous triad as a case were closely observed based on their dialogue threads by recording their collaborative learning processes. Such a triad consisted of high, medium and low achievers with regard to their ICT scores last semester.

Procedures for administering the flipped classroom

On the day before class, participants were asked for learning the micro-lesson video about how to make a colorful ring and elaborating a knowledge map about contents involved in the micro-lesson video. The micro-lesson video lasted for about 6 minutes. In class, participants were divided into triads to develop a cover of DVD hand in hand under the guidance of collaboration script. Before working on the task, the instructor concisely illustrated the task requirements and showed a simple worked example to students, which took about 5 minutes. Students spent about 35 minutes working on the cover of a disc including their discussion.

Learning materials

In this study, a micro-lesson video as Figure 2 for pre-class learning was developed about how to make a colorful ring. It mainly introduced such tools as ruler, angle interface blending options and layer style during designing a colorful ring. In class, an example was presented in the PPT for DVD's pro and con covers.

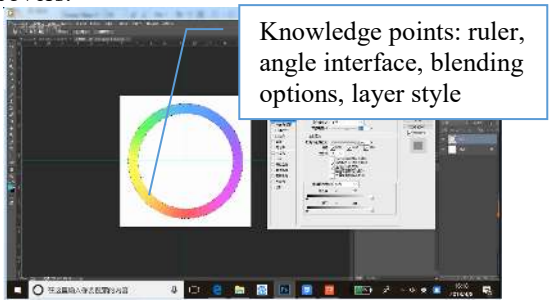

Figure 2. Micro-lesson video content

A collaboration script was provided for triads involving how to determine the topic of the DVD's cover, how to prepare the required technology for the DVD's cover and how to comment on their e-work.

An analytic schema for the student-centered flipped classroom activity

As a systematic activity, the flipped classroom is composed of elements as Figure 3 (Lazarou, Sutherland, & Erduran, 2016).

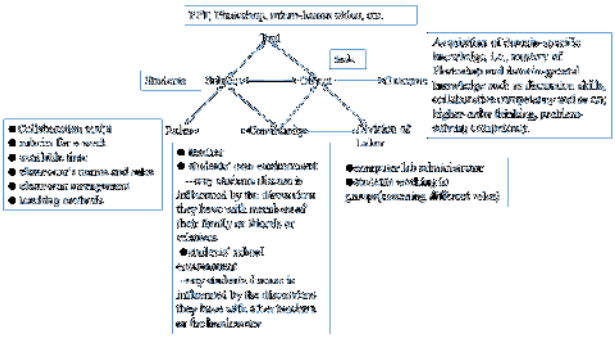

Figure 3. The student-centered flipped classroom activity

In the flipped classroom, the primary contradictions refer to tensions within each component of an activity. The secondary contradictions involve tensions between subject, rules, tools, community, etc. This study focuses the first-level contradiction on students as the subject, i.e., students' attitude towards collaborative learning and students' prior knowledge and skills. Second-level contradictions were tensions mainly between the subject and division of labor or tools or community. Here tensions mainly focus on appropriateness of labor division in a group, timeliness of teacher's mentorship and partners' help, abundance of learning tools or materials.

A coding scheme for the triad's interactions

In light of the AT analysis method (Lazarou, Sutherland, & Erduran, 2016) and the coding scheme for cognitive regulation in collaborative learning (Järvelä & Hadwin, 2013), the following coding scheme was developed as Table 1, which was checked by three experts. As well, the coding scheme was seen in Table 2 for judgment whether the cognitive regulation facilitates or inhibits the group progress (Iiskala, Vauras, Lehtinen, & Salonen, 2011).

Table 1. The coding scheme for the triad's interactions from AT perspective

Types of cognitive regulation	**Self-regulated cognition (1st level contradiction)**	**Co-regulated cognition (2nd level contradiction)**	**Shared regulation of cognition (2nd level contradiction)**

What's regulated?	●Task knowledge	●My task perceptions	●Each other's task perceptions	●Our negotiation of common task perceptions
	●Strategy knowledge and use ●Goals and plans	●My strategy knowledge and use. ●My goals and standards for this task. ●My plans for working together.	●Each other's strategy knowledge and use. ●Each other's goals and standards for this task. ●Each other's plans for this task.	●Our use of team processes and strategies for succeeding with this task. ●Strategy knowledge we create together.
				●Shared goals and alignment of individual task perceptions and goals.
	●Motivation and emotions	●My engagement and positive/ negative emotional feelings.	●Awareness of other's engagement and positive/ negative feelings in this task.	●Awareness of our engagement and positive/ negative feelings in this task.
	●Self-knowledge	●My goal progress evaluations.	●Goal progress evaluations of each other.	●Negotiated evaluations of goal progress. ●Knowledge this group's strengths & weaknesses with respect to this task. ●Perceptions & evaluations of our collective progress.
Examples		"This task is really worked by three idiots." (task perceptions) "A little bigger, this task is to make a ring." (inappropriate task goals) "I'm very poor in PS., let you do it." (negative engagement) "Pressing Ctrl + Alt + Z is too boring." (negative feelings in working on the task)	"Here is the ruler. " (facilitating task progress) "Aha, don't interrupt me and I have my own ideas." (each other's perceptions of the task) "Let him continue this." (Awareness of other's engagement, hindering contributions to the task) "We wonder whether we split that image just now." (for help from the teacher, each other's strategy knowledge and use)	Student A puts forward an opinion, student B gives an alternative opinion. Student C supports A and explains reasons. After that the discussion is continued. An effective method by discussion is agreed on and immediately implemented. (strategy knowledge we create together) "That's ok! It's too perfect." (shared feelings of goal progress

			)

Table 2. Functions of cognitive regulation over the group progress

functions	Sub-functions	description	explanation	examples
facilitate		When the cognitive regulation occurs, the activity is deeply proceeded in the previous direction.	--	
	●activate	Coinciding with the previous direction, a new factor is activated.	Triads analyze problems in front of the computer and formulates a problem model.	Student B：" No, no, no, we can do like this, deleting the middle block" Student A："Let's do like this" (doing in person). Student C：(Go on regulating the e-work). (activate)
	●confirm	Recognize that the proceeding direction is right.	Triads examine whether the proceeding method is appropriate.	Student B: "I remember here can it be realized", (demonstrating) (confirm)
inhibit		When the cognitive regulation occurs, the proceeding direction is suspended.	--	
	●slow	Slow down the previous progress	Triads question each other about what was done and go on solving the problem doubtfully.	Student A: "I remember here is the tool and why here it isn't." (slow)
	●change	Change the proceeding direction	Triads disapprove the previous solution and continue the task with alternative approaches.	Student B: "Mr., if it is subtracted from the selected zone, our operation takes no effect." Teacher: "Now you don't need to subtract from the selected zone, you can drawing a circle again." (change)
	●stop	Stop the proceeding direction, but a new direction does not arise yet .	Triads agree on finishing the proceeding work, but they do not	Student A: "Here is bevel and emboss." "Don't be too big, please" "That's ok." (stop)

			come up with a new approach to it yet.	

RESULTS

This study especially transcribed the heterogeneous triad's interactions into texts including dialogues, behaviors and emotional expressions. After that, functions of cognitive regulation and contradictions between elements of an activity were analyzed by two trained coders, whose Kappa's coefficient was .78, based on the analytic frame for the student-centered flipped classroom activity as Figure 3 and coding schemes for in-class cognitive regulation as Tables 1 and 2.

Contradictions between the subject and the division of labor

From the activity-theoretical perspective, each member of the heterogeneous triad was looked upon as the subject of the student-centered flipped classroom activity, peer as the division of labor. The recorded video about interactions of such a triad was transcribed into 242 moves, in which 30% threads were recognized as self-regulation of cognition, 30% threads as co-regulation of cognition and 33% threads as shared regulation of cognition. The excerpt was illustrated in Table 3.

Table 3. An excerpt for interactions between the subject and the division of labor

Participants	**Dialog & behavior**	**Regulation of cognition**	**Functions**	**Contradiction level**
A: high-achiever B: medium-achiever C: low-achiever	B: "It's time to new a layer."	Shared regulation (perceptions of team progress)	Facilitate-activate	no
	A: "800 pixels multiply 800 pixels."	Self-regulation	Facilitate-activate	no
	B: "Ruler, then ruler."	Co-regulation	Facilitate-activate	no
	A: "Is that what our teacher asked us to watch yesterday?"	Co-regulation	Facilitate-confirm	no
A: high-achiever B: medium-achiever C: low-achiever	B: "Firstly take out the ruler."	Co-regulation	Facilitate-activate	no
	C: "Let me watch the video first." "Is time enough?" (review the video)	Self-regulation	Inhibit-change	1st

Table 3 only listed the partial interactions of this triad. From the whole transcription, such the heterogeneous triad has three kinds of cognitive regulation with the equivalent proportion. At large, each member within such a triad can construct his or her own goals. For instance, "The images are firstly picked up for spare use", which means that no primary contradiction occurred. During working on the task, the low-achiever could favor partners to solve the problems with the help of the micro-lesson video. Within such a triad, all the members positively took part in the discussion and were ready to contribute to the teamwork. As an example, "Here seems the right-hand button and press it", it just stands for the interaction between the subject and the division of labor. Less secondary contradictions took place during the triad's interactions. The more capable student could guide the less capable one to solve the problem by explaining the potential knowledge and tools or demonstrating. For example, "Firstly we should save the file as the PS format in order to reedit it. Or else, the jpg file cannot be edited again." Notwithstanding, 10% interactions were still negative, where the capable student did not accept other members' suggestion or he rejected help from others, e.g., "I know. Don't do it." At that time, the secondary contradiction occurred hindering effective collaboration.

Contradictions between the subject and tools

Here the triad as a whole was considered as the subject of an activity. Tools were mainly confined to

PS software. Interactions between the subject and tools were encoded as an excerpt as Table 4.

Table 4. An excerpt for interactions between the subject and tools

Participants	**Dialog & behavior**	**Regulation of cognition**	**Functions**	**Contradiction level**
A: high-achiever B: medium-achiever C: low-achiever **PS** software	C: "How to do reverse operation?"	Self-regulation	inhibit-slow	2nd
	B: "Right click, but here seems the tool." (demonstrating)	Self-regulation and co-regulation	Inhibit-slow	2nd
	C: "Wrong! Here seems the tool for selection." (demonstrating)	Self-regulation and co-regulation	inhibit-change	2nd
	A: "Then fill up."	Co-regulation	Facilitate-confirm	

From Table 4, tensions arose between the triad and PS software, i.e. secondary contradictions. Due to the PS version different from before, students could not find the tool as well as before. Whilst, the menu bar was the same as before. Some members could use the menu bar to find the tool and others could not, randomly clicking on the interface. Finally, they uncovered the tool with the help of the micro-lesson video. Take an example, "Ai, Here was the tool before, now here it isn't." It illustrated that contradictions between the subject and tools resulted from unfamiliarity with the new PS version or incompletely understanding what the micro-lesson video transferred before class.

Contradictions between the subject and the community

Here the triad as a whole was seen as the subject, the teacher as one member of the community. Their interactions were encoded as Table 5.

Table 5. An excerpt for interactions between the subject and the community

Participants	**Dialog & behavior**	**Regulation of cognition**	**Functions**	**Contradiction level**
A: high-achiever	A: "Mr., do we need input the title on the cover?"	Shared regulation	facilitate-activate	
B: medium-achiever	Teacher: "That depends on your demands."	Co-regulation	Inhibit-slow	2nd
C: low-achiever	C: "Then we don't add the title. It's over."	Shared regulation	Inhibit-stop	2nd
Teacher	Teacher: "If you feel it needs the title, please add it."	Co-regulation	Facilitate-activate	

During working on the task, they consulted only one problem with their teacher. From Table 5, the problem was very simple, only for confirmation whether the title was required. The teacher only implied the answer to them, which gave rise to secondary contradictions.

CONCLUSIONS AND DISCUSSION

The observed triad sometimes faced primary or secondary contradictions, when they could relieve those tensions by teacher's inspiration, partners' co-regulation and self-regulation. From the AT perspective, conclusions were drawn as following:

1) Co-regulation and shared regulation assumes very important roles within the heterogeneous triad's interactions

The heterogeneous triad regulated each other's and team's cognition more smoothly, especially the low-achiever could get favors from high and medium achievers, who would enhance their own understanding and application of knowledge.

2) The secondary contradictions mainly occur within the heterogeneous triad's interactions

Judging from the results of interaction analysis, secondary contradictions often occur between the subject and the division of labor or tools or the community. Those contradictions can be resolved by co-regulation and shared regulation. Their collaboration is harmonious.

In this study, only the student-centered activity was scrutinized and in the future the teacher-centered activity of preparation for the flipped learning should also be analyzed.

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