Effects of a visualization-based group awareness tool on in-service teachers' interaction behaviors and performance in a lesson study

Axi Wang, Shengquan Yu, Minhong Wang & Ling Chen

Published online: 26 Apr 2019.

Submit your article to this journal ⎘

Article views: 55

View Crossmark data ⎘

Routledge
Taylor & Francis Group

Check for updates

Effects of a visualization-based group awareness tool on in-service teachers' interaction behaviors and performance in a lesson study

Axi Wang [a,b], Shengquan Yu[a,b], Minhong Wang[c] and Ling Chen[a,b]

[a]School of Educational Technology, Faculty of Education, Beijing Normal University, Beijing, People's Republic of China; [b]Advanced Innovation Center for Future Education, Beijing Normal University, Beijing, People's Republic of China; [c]Faculty of Education, The University of Hong Kong, Hong Kong, People's Republic of China

ABSTRACT

Lesson study provides an opportunity for teachers to improve their knowledge and skills of classroom teaching, where a group of teachers collaboratively research, plan, and observe a series of lessons followed by ongoing discussions and reflections. While social interaction between group members plays an important role in collaborative learning contexts, there are concerns about the quality of interaction among teachers in a lesson study (e.g. inadequate engagement in discussion, and the process of interaction dominated by a few politically strong teachers). To address these issues, this study proposed a visualization-based group awareness tool that visualized individual and group behaviors and performance as well as peer comments to facilitate group interaction in a lesson study implemented on an online platform. Twenty-four primary school teachers participated in the study, and their interaction behaviors and lesson plans generated during the study were collected for analysis. The results revealed positive effects of the visualization-based group awareness tool on enhancing teachers' engagement in social interaction and fostering coherent interaction among members during the lesson study, and improving teachers' performance in learning process design through the study.

1. Introduction

Lesson study is a professional development practice that a group of teachers collaboratively design, observe and reflect systematically on one lesson (Leavy & Hourigan, 2016). As an effective method for teacher professional development (Dudley, 2013; Lewis, Perry, & Hurd, 2004), it has been widely adopted in Japan, England, the United States and other countries. Similar to lesson study, in mainland China, the school or country-based three-level teaching research system has been implemented since 1952, and the disciplinary or interdisciplinary Teaching Research Groups (TRG) exist in almost all schools (Yang, 2009). Unlike western culture, the classroom teaching of Chinese teachers is open for peer observation, studies and discussion. TRG is the basic unit in the three-level teaching research network in mainland China. It is an organization that helps teachers to improve professional learning and solve problems in teaching practices.

The collaborative nature of lesson study allows teachers to obtain in-depth knowledge about teaching and learning as well as students' needs (Dudley, 2013). Lesson study promotes cooperation among teachers and the formation of teacher communities of practice; moreover, it help make various types of knowledge and resources more visible and accessible to teachers (Cajkler, Wood,

---

Norton, Pedder, & Xu, 2015; Dudley, 2016). On the other hand, lesson study is a time-consuming practice. During a lesson study, teachers need to collaboratively plan the lesson, observe its implementation, and discuss and share thoughts on the revision of the lesson (Dudley, 2013; Fernandez & Yoshida, 2004; Saito, 2012). What's more, a complete process of lesson study often involves two or three cycles. Accordingly, researchers have highlighted the need for more technology tools to support lesson study (Dudley, 2013; Larssen et al., 2017). Meanwhile, there are concerns about the quality of social interaction among teachers in a lesson study. For example, teachers tend to spend more time on lesson plans and observations, but less or inadequate time on discussions and reflections (Saito, 2012). Moreover, the existence of social loafing and free rider behaviors (i.e. the tendency to reduce individual effort when working in groups compared to working alone) makes it difficult to complete a lesson study and benefit from the experience (Lee, 2008). Other researchers found that the process of interaction in a lesson study tends to be dominated by a few political strong teachers, and the other participants were forced to conform to their ideas (Saito, 2012; Saito & Atencio, 2013).

In response to the interaction problems such as social loafing and free rider in collaborative learning contexts, researchers have explored the use of group awareness tools and reported their positive effects on facilitating group interaction and stimulating group members to participate equally in computer-supported collaborative learning contexts (Janssen, Erkens, & Kirschner, 2011; Phielix, Prins, Kirschner, Erkens, & Jaspers, 2011). Such tools allow group members to be informed about individual and group information in various aspects (e.g. level of knowledge and skill, contribution, interaction frequency) (Gross, Stary, & Totter, 2005). They can facilitate the process of interaction between group members on the basis of the shared information throughout the course of collaboration. Existing studies on group awareness in collaborative learning have focused on student learning in higher education (Buder & Bodemer, 2008; Fransen, Kirschner, & Erkens, 2011; Ming, Leping, & Li, 2018; Phielix et al., 2011) and secondary education contexts (Janssen et al., 2011). It is unknown whether the aforementioned problem about social interaction among teachers in a lesson study can be addressed by group awareness tools.

This study proposed a visualization-based group awareness tool that visualized individual and group behavior and performance as well as peer comments to facilitate social interaction among teachers in a lesson study. Primary school teachers participated in the lesson study implemented at an online platform. Their interaction behaviors and lesson plans generated during the lesson study were analyzed to examine the effects of the proposed approach.

2. Review of the literature

2.1. Group awareness and tools

Group awareness has received increased attention in computer-supported collaborative learning (CSCL). It refers to being informed about various aspects of the group and its members (Gross et al., 2005). The goal of group awareness research is to support group members to perceive the functioning of self and group on the basis of individual and group-related information (Bodemer & Dehler, 2011). There are three kinds of group awareness, which are behavioral, cognitive, and social awareness. Behavioral awareness refers to awareness of the up-to-the-minute knowledge of other group members' activities, such as history of actions, frequency of interactions, and the number of contributions (Hajar, Ahmad, Abu, Kamariah, & Maryam, 2016). Cognitive awareness refers to the level of knowledge, skills, and prior knowledge of task that one is aware of with other group members (Hajar et al., 2016). Social awareness informs about the functioning of the group as perceived by the collaborators (Fransen et al., 2011).

To support group awareness in CSCL, many tools have been developed to collect and present group- and individual-related information on multiple aspects throughout the course of collaboration, which have shown promising effects on facilitating the communication and coordination

processes and improving the quality of group work (Bodemer & Dehler, 2011). Researchers found that group awareness tools help group members to obtain required information to collaborate effectively so as to improve group and individual performance (Bodemer & Dehler, 2011; Buder & Bodemer, 2008; Jongsawat & Premchaiswadi, 2011; Phielix et al., 2011). Other studies reported that group awareness tools can reduce the behavior of social loafing or free riding (Janssen et al., 2011) and enhance learners' participation (Ming et al., 2018). Moreover, group awareness tools can change the behavior of individual group members who dominate the process of group discussion (Phielix et al., 2011), and stimulate group members to participate equally (Janssen et al., 2011). In addition, researchers argued that group size may affect the effects of group awareness tools. While most existing studies adopted the groups of three or four members, the effects of group awareness tools might be different or greater if the group size is increased (Janssen et al., 2011; Ming et al., 2018).

Regarding the design and utilization of group awareness tools, many researchers emphasize the importance of visualizing individual and group information in multiple aspects. For example, Janssen et al. (2011) developed a Participation Tool, which visualized the contribution of every group member for comparison between members and for group awareness. Phielix et al. (2011) integrated two visualization-based tools of peer feedback and reflection to enhance group performance in a CSCL environment by allowing group members to recognize and compare individual performance in the process of interaction. Ming et al. (2018) proposed an online collaborative writing tool with a group awareness functionality. This tool could continuously collect the writing behavior of group members, and then analyze, visualize and compare their engagement intensity of group members.

2.2. Social network analysis of interactive behaviors

Social Network Analysis is helpful to understand students' engagement and interactions in computer-supported collaborative learning contexts by using a mathematical manner to analyze participants' positions in a social network (Liu, Chen, & Tai, 2017). SNA focuses on a collection of social actors and their relationships. It is an approach and set of techniques used to study the exchange of information or resources among actors, in which actors are represented as nodes in the network and relationships as connectors between nodes (Haythornthwaite, 1996). As a major data analysis method, SNA has been increasingly used in educational research to illustrate different variables such as relationship, emotion and other social phenomena (Lee & Bonk, 2016).

There are several tools provided by SNA to understand interaction patterns among individual learners (Wassermann & Faust, 1994). Four frequently used measures in SNA were point centrality of individual node, distance-based cohesion, network density and centralization of the whole network. Point centrality of a node is defined as the number of ties this node has. The higher of individual point centrality, the greater the center of the network (Rienties et al., 2012). Previous studies suggested that point centrality is useful to understand how a learner's position in a network affects that learner's achievement (Dietz-Uhler & Bishop-Clark, 2001). The distance-based cohesion of a network refers to the degree to which members in the network are interconnected. Its value ranges from 0 to 1. A larger value of a network indicates the greater cohesiveness of the network. The network density is an indicator for the general of connectedness of the network (Otte & Rousseau, 2002). In the same scale networks, the higher the density, the higher the cohesion of the network, and the closer the connection among the members (Scott, 2012). Network concentration is used to measure the degree of aggregation of the entire network to the center (Scott, 2012). With the help of SNA, Shen, Nuankhieo, Huang, Amelung, and Laffey (2008) found that social interaction influences the sense of community of learners in online learning contexts. However, current studies on the SNA of networked learning have focused on the fields of higher education and elementary education, with inadequate attention to the field of in-service teacher education. While lesson study has been increasingly promoted in teacher education, it is not clear how teachers collaborate with each other and participate in online activities in a lesson study.

3. Research questions

This study aimed to facilitate social interaction among teachers in a lesson study by visualizing social interaction using a group awareness tool and to examine the effects of the tool on teachers' engagement, interaction, and performance. The lesson study was implemented on an online platform, and a visualization-based group awareness tool was incorporated into the platform. The participants' interaction behaviors and performance were analyzed and compared to those generated by other teachers not using the visualization-based group awareness tool.

The research questions (RQs) are specified as follows.

RQ1. Can the visualization-based group awareness tool influence teachers' engagement in social interaction in a lesson study?

RQ2. Can the visualization-based group awareness tool reduce domination behaviors in social interaction among teachers in a lesson study?

RQ3. Can the visualization-based group awareness tool improve teachers' instructional design performance in a lesson study?

RQ4. What are the teachers' comments on the visualization-based group awareness tool?

4. Method

4.1. Participants

The participants were twenty-four primary school teachers (20 females and 4 males), who were teaching 3rd and 4th Grade Chinese language and had about 10 years of teaching experience on average. They all had some experience of using web-based systems for lesson study prior to this study. They gave informed consent to participate in this study, which received the ethical approval from the researcher's university. The present study used the quasi-experimental research method to investigate the effects of the visualization-based group awareness tool on teachers' interaction behaviors in a lesson study. To support the sharing of knowledge on teaching similar content subjects, twelve 3rd Grade Chinese teachers were assigned to the experimental group, and other twelve 4th Grade Chinese teachers were assigned to the comparison group. The experimental group could access the proposed visualization-based group awareness tool, while the comparison group couldn't access this tool.

4.2. Learning environment

4.2.1. The Online Lesson Study Platform for in-service teachers

In this study, teachers adopted an Online Lesson Study Platform (OLSP, see Figure 1), which was developed on the basis of the Learning Cell supporting online collaborative learning (Yu, Yang, Cheng, & Wang, 2015). The system was designed to support the typical process of lesson study, namely preparing lesson plans, peer review and discussion on teaching videos, writing reflections, and further learning for improvement.

(1) *In the phase of preparing for and uploading lesson plans and teaching videos*, every teacher needs to upload their lesson plans and teaching videos to OLSP. (2) *In the phase of peer review and discussion on teaching videos*, firstly, teachers reviewed each other's teaching videos in groups, provided peer feedback for improvement, and discussed with the visualization-based group awareness tool (notes: only teachers in the experimental group could use the group awareness tool in discussion). (3) *In the phase of writing teaching reflection journal and discussing on approaches for improvement*, firstly, every teacher wrote teaching reflection journal independently according to their own teaching situation and peer feedback suggestions. Then teachers discussed on approaches for improvement. (4) *In the phase of further learning*, teachers received the recommendation of
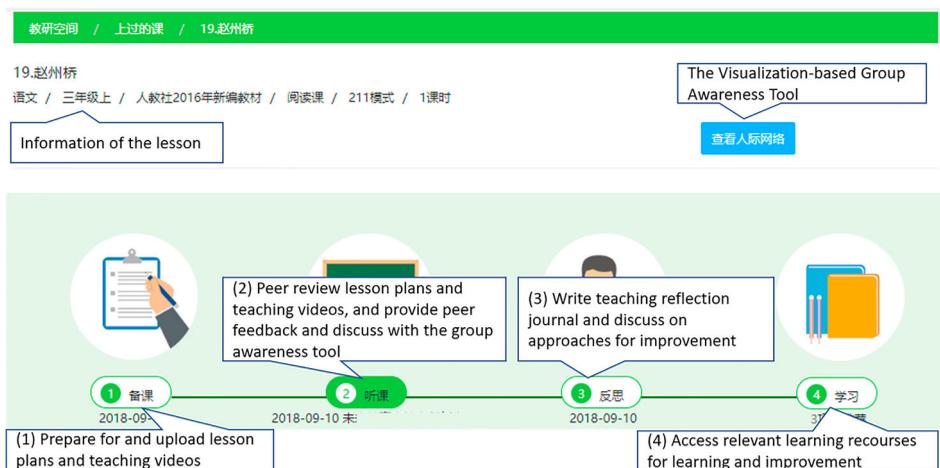
Figure 1. The Online Lesson Study Platform (OLSP).

personalized learning generated by the system based on individual performance. Then every teacher could access relevant learning recourses for learning and improvement.

4.2.2. The visualization-based group awareness tool in the OLSP

A visualization-based group awareness tool was incorporated into the system to facilitate group interaction. As shown in Figure 2, the tool allowed each group member to view the following information in visual formats: (1) information of the lesson and the participating teachers; (2) comments from other members categorized as strength and aspects for improvement together with relevant learning resources; (3) comparisons of behavior and performance at the individual and group levels in lesson study. This tool was developed to automatically and continuously collect, update and visualize the participants' direct operational behavior data such as teachers' preparation for lesson plans, peer review of teaching videos, writing reflection journals, and discussion with others, rather than the indirect data of participants' participation which were collected by observation, or perceived social behavior by the self-report. The visualized individual and group performance were continuously updated throughout the lesson study.

With the help of the Visualization-based Group Awareness Tool, each member could observe the participation and performance of his/herself and other members throughout the lesson study to facilitate the comparison and regulation of individual performance so as to stimulate active participation and interaction for improving performance.

4.3. Measures and instruments

4.3.1. UCINET for analyzing the interactive behaviors

To analyze social interactions among teachers in the lesson study, this study used the SNA method to analyze the participants' interaction behaviors occurred in preparation for lesson plans, peer review of teaching videos, writing reflection journals, and discussion with others. This study used the UCINET software, one SNA tool, to make the analysis. The measurement indexes of social network including point centrality of individual node, distance-based cohesion, network density and centralization of the whole network were used for analysis. The point centrality of individual node can reflect teacher's engagement in social interaction. The distance-based cohesion, network density and centralization of the whole network can reflect whether there exists dominant behavior in the network.
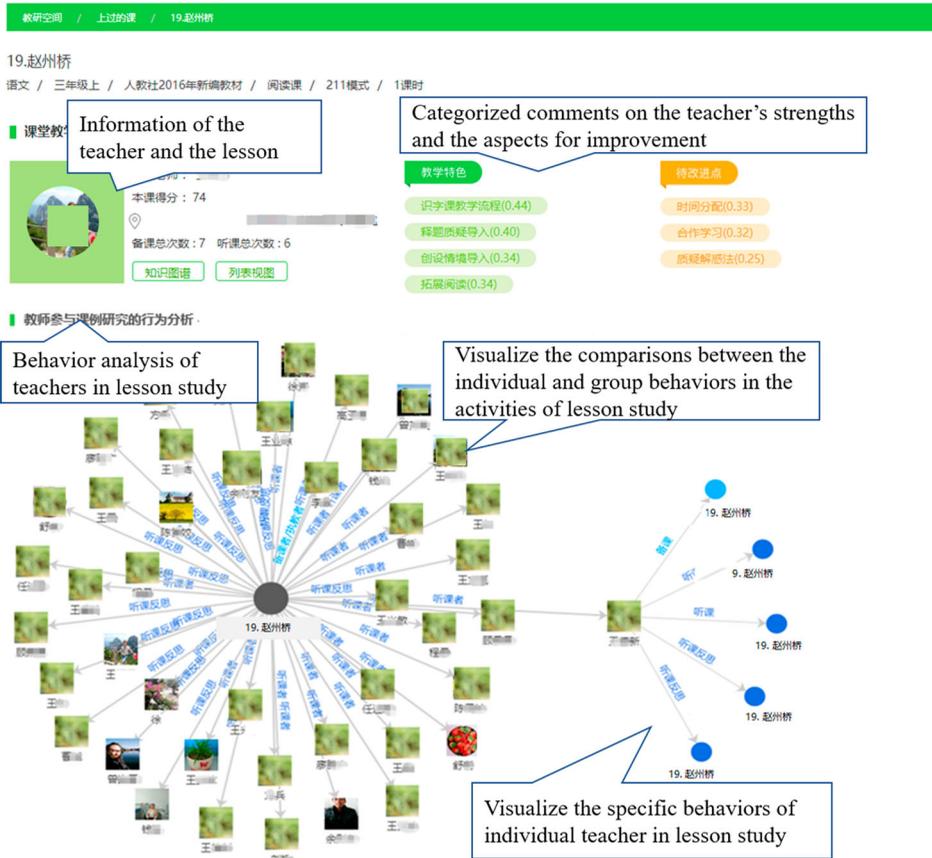
Figure 2. A visualization-based Group Awareness Tool in the Online Lesson Study Platform.

4.3.2. Performance-based instructional design diagnosis framework

The performance-based Instructional Design Diagnosis Framework developed by Ma, Xin, and Du (2018) was used to assess the teachers' instructional design performance reflected in their lesson plans. Some items in the scoring framework were adapted for the context of lesson study. The framework involves three sub-domains: front-end analysis (it refers to analyze the learners and identify the learning goals and content, four items), learning process design (seven items), and pedagogies and teaching ideas (four items). Each item was rated in a lesson plan provided by a teacher. Examples of the items included: *Identify and describe the learning goals* (Front-end analysis); *Select or develop effective strategies for guiding the students' reading* (Learning process design); *Development of the students' creative thinking in language learning* (Pedagogies and teaching ideas). Each lesson plan was assessed by two domain experts who possessed the knowledge and skills in teaching the Chinese language subject. They also received necessary training of using the assessment framework with adequate practice before this study. The two raters assessed the participants' lesson plans blindly and independently. All differences in their assessment results were resolved via discussion.

4.3.3. Interview on visualization-based group awareness tool

Semi-structured interviews were arranged with the teachers to collect their comments on the advantages and disadvantages of the Visualization-based Group Awareness Tool. The interview outline was designed based on the outline developed by Hsia, Huang, and Hwang (2016). The interview results

were used to verify the research findings and provide direction to optimize and improve the Visualization-based Group Awareness Tool in the future.

4.4. Learning activities and experimental procedure

The study lasted 8 weeks for two rounds of lesson study (see Figure 3). In Week 1, the participants were given the training on how to use the Online Lesson Study Platform and how to prepare for lesson plans and teaching videos. They also worked together as a group to discuss the goals and schedules of the lesson study. Each participant was requested to submit a lesson plan to the system. They could also upload the teaching video of the lesson delivered by him/her around the first week, which was encouraged but not compulsory.
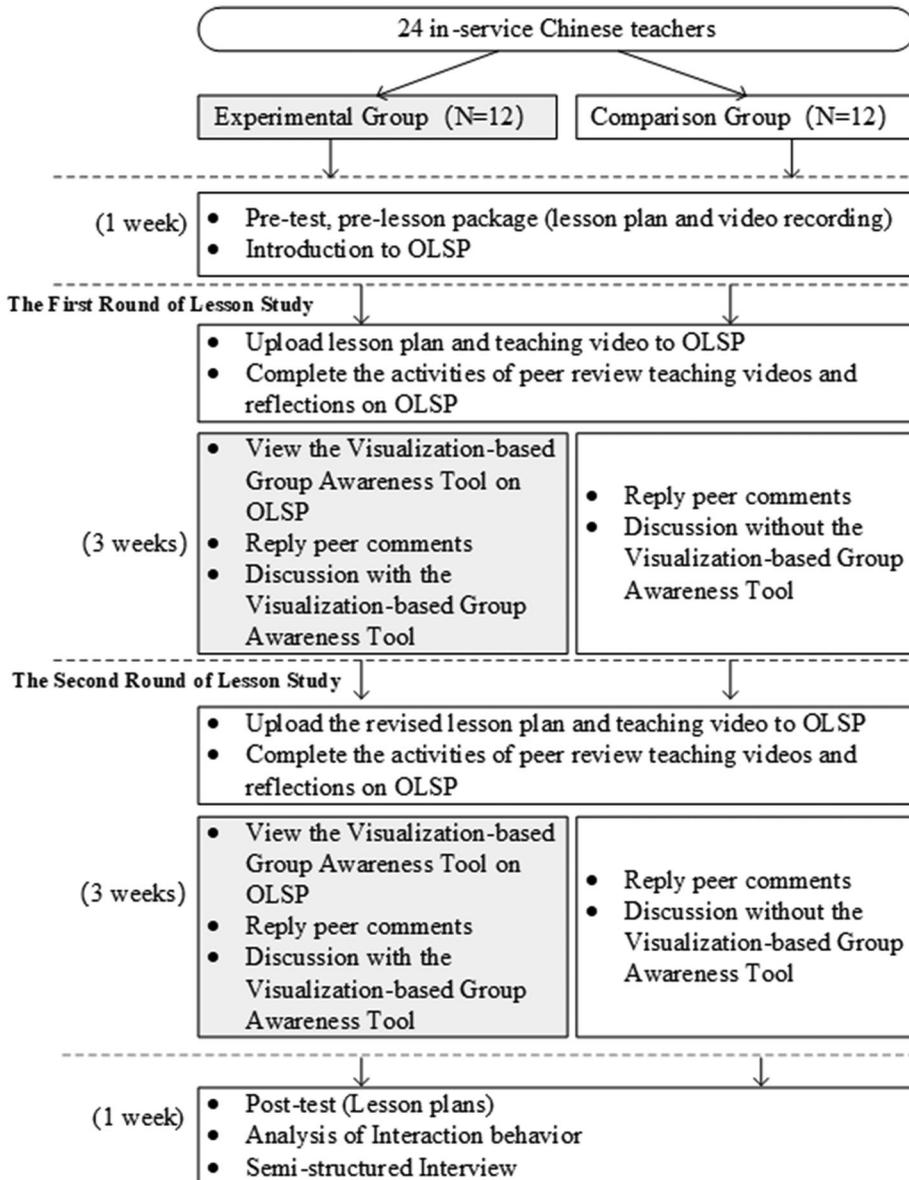

Figure 3. Procedure of the experiment.

In Week 2, the participants used the Online Lesson Study Platform to view the lesson plans and teaching videos uploaded by other members in the group for observation and peer learning. They were asked to provide peer feedback by the end of this week. The feedback included the comments on the peer's strengths in teaching, suggestions for improvement, and recommended recourse and/or references. In Week 3, the participants could view the online feedback; they could also give responses to the feedback through the system if they wanted.

In Week 4, the participant first reflected on their teaching performance individually based on peer feedback from other members, and then gathered together as a group to reflect on their performance and discuss on approaches for improvement. To facilitate individual engagement, each participant in the experimental group was given access to the visualization-based group awareness tool at any time. Such a tool was not provided to teachers in the comparison group.

The second round of lesson study started in Week 5. In Week 5, the participants submitted their second lesson plan (compulsory) and teaching video (optional) of a lesson delivered by him/her in the 5th week. The activities for Week 6 to Week 8 were the same with those for Week 2 to Week 4.

In Week 8, this study adopted the tool of social network analysis to analyze interactive behaviors of in-service teachers. The performance-based Instructional Design Diagnosis Framework was used to analyze teachers' performance through their lesson plans. Semi-structured face-to-face interviews were arranged with six teachers who were randomly selected from the experimental group.

4.5. Data analysis

The collected data were analyzed using the following methods.

- The Social Network Analysis method was adopted to analyze the participants' interaction behaviors of both groups.
- Independent-samples t tests were used to compare the differences in the centrality of individual members between the experimental and the comparison groups.
- Teachers' instructional design performance reflected in their lesson plans generated in the two rounds of lesson study (i.e. pre-test and post-test) was scored.
- Independent samples t tests were conducted on the scores of lesson plans to compare the differences in teachers' instructional design performance between the experimental and comparison groups.
- Cohen's d effect size was calculated for the performance scores and point centrality to illustrate the extent of the practical difference between the two groups in the performance scores and social interaction.

5. Results

5.1. Can the visualization-based group awareness tool influence teachers' engagement in social interaction in a lesson study?

In this study, The UCINET software was used to analyze the point centrality, network density and network concentration of the experimental group and the comparison group. The descriptive statistics of the point centrality are presented in Table 1. The normal test of the data showed that the data were consistent with normal distribution. Therefore, the independent-samples t test was used

Table 1. Descriptive statistics and t tests on point centrality of individual node.

Measure	Group	N	Mean	SD	t	p	d
Point Centrality	Experimental group	12	47.75	25.34	2.13	0.044*	0.87
	Comparison group	12	28.33	18.79			

*$p < 0.05$.

to analyze whether there is a significant difference in the point centrality of individual node between the experimental group and the comparison.

As shown in Table 1, there is a significant difference between the experimental group and comparison group, for the point centrality of individual node ($t = 2.13$, $p = 0.044 < 0.05$, Cohen's $d = 0.87$). The point centrality of the experimental group (Mean = 47.75, SD = 25.34) was higher than that of the comparison group (Mean = 28.33, SD = 18.79). This revealed that the teachers in the experimental group were more actively engaged in social interaction than those in the comparison group.

5.2. Can the visualization-based group awareness tool reduce domination behaviors in social interaction among teachers in a lesson study?

The results of SNA analysis showed that the distance-based cohesion of the experimental group (Distance-based cohesion = 0.947) was greater than that of the comparison group (Distance-based cohesion = 0.717). The network density of the experimental group (Density = 2.288) was greater than that of the comparison group (Density = 1.288). These differences revealed that the teachers were more strongly tied to each other in the experimental group. The network concentration of the experimental group (Network Centralization = 28.18%) was higher than that of the comparison group (Network Centralization = 23.18%), which indicated that teachers in the experimental group towards the network center were higher than teachers in the comparison group, as shown in Table 2.

In this study, the UCINET and NetDraw software were used to generate the social network of the experimental group and comparison group. It could be seen from the social network of the comparison group (see Figure 4) that ZXX, CBB and LJM had more interactions with each other, dominating the interactive process of lesson study. As shown in Figure 5, teachers in the experimental group more actively and equally participate in the interactive process of lesson study, compares to the

Table 2. Social network analysis of experimental group and comparison group.

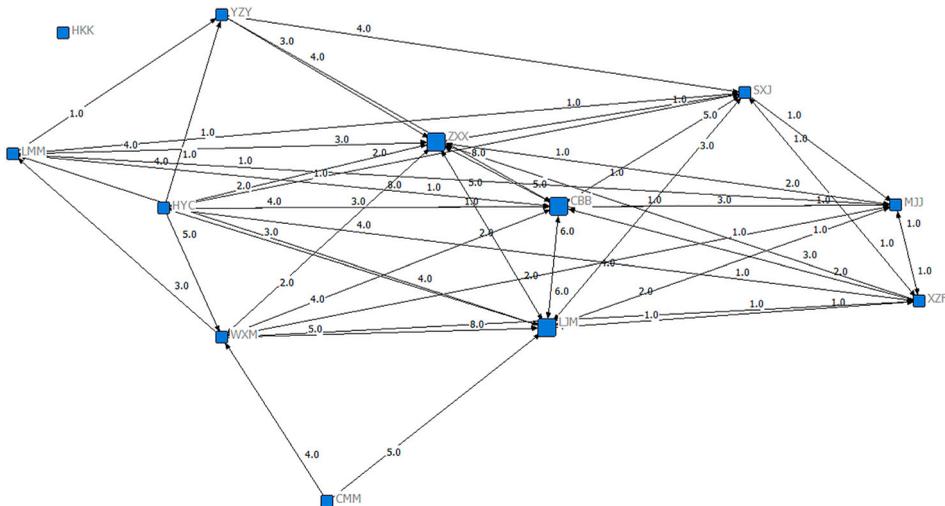| Group	Distance-based cohesion	Density	Network centralization
Comparison group	0.717	1.288	23.18%
Experimental group	0.947	2.288	28.18%

Figure 4. The social network of teachers' online interaction in the comparison group.
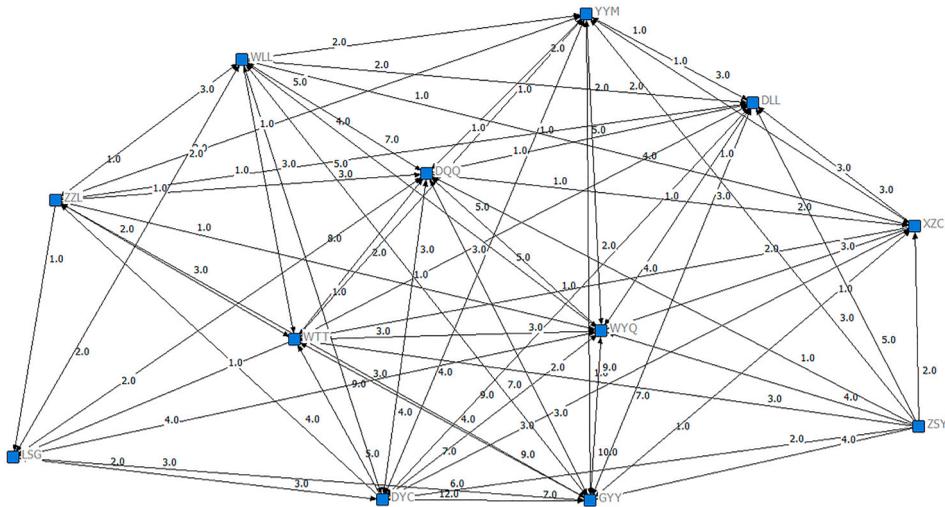
Figure 5. The social network of teachers' online interaction in the experimental group.

comparison group. In other words, the network of the experimental group is more cohesive than that of the comparison group.

5.3. Can the visualization-based group awareness tool improve teachers' instructional design performance in a lesson study?

Group differences in the pre-test scores. The independent samples *t* tests showed no significant differences in the pre-test performance scores between the experimental group and comparison group in all sub-domains: Front-end analysis ($t = 0.50$, $p = 0.621 > 0.05$), Learning process design ($t = 1.64$, $p = 0.116 > 0.05$), Pedagogies and teaching ideas ($t = 0.98$, $p = 0.337 > 0.05$), as shown in Table 3.

Group differences in the post-test scores. The *t* tests on the post-test performance scores revealed that the experimental group outperformed the comparison group in one sub-domain (see Table 3): Learning process design ($t = 2.21$, $p = 0.038 < 0.05$, Cohen's $d = 0.90$). But, there were no differences between the two groups in the post-test performance scores for the other two sub-domains: Front-end analysis ($t = 1.74$, $p = 0.099 > 0.05$), Pedagogies and teaching ideas ($t = 1.85$, $p = 0.077 > 0.05$).

5.4. What are the teachers' comments on the visualization-based group awareness tool?

Semi-structured face-to-face interviews were arranged with six teachers who were randomly selected from the experimental group. The main contents of the interview include the advantages and

Table 3. Descriptive statistics and independent samples *t* tests on group differences in the pre-test and post-test performance scores.

| Aspect | Condition | Experimental group | | | Comparison group | | | t | p |
		N	Mean	SD	N	Mean	SD		
Front-end analysis	a	12	6.83	3.59	12	4.77	1.97	1.74	0.099
	b	12	5.23	2.78	12	4.71	2.28	0.50	0.621
Learning process design	a	12	45.13	8.26	12	37.50	8.67	2.21	0.038*
	b	12	31.35	8.20	12	25.54	9.17	1.64	0.116
Pedagogies and teaching ideas	a	12	23.44	5.52	12	19.46	4.99	1.85	0.077
	b	12	14.06	6.32	12	11.40	6.98	0.98	0.337
Total	a	12	75.40	14.80	12	61.73	13.92	2.33	0.029*
	b	12	50.65	15.97	12	41.65	16.57	1.36	0.189

a = post-test; b = pre-test.
*$p < 0.05$.

disadvantages of the visualization-based group awareness tool, operation interaction and suggestions for improvement.

5.4.1. The visualization-based group awareness tool enhances engagement in interaction.

The teachers generally agreed that the visualization-based group awareness tools are very helpful for enhancing engagement in social interaction. As one teacher (ZZL) said, "Through the group awareness tool, I could see peer comments on my lesson summarized in a categorized format and then discuss with different members on different issues." Another teacher (WTT) indicated that the group awareness tool could help her quickly find some expert teachers when she need help. In addition, other teachers (YYM, ZZL) pointed out that they could know and share peer teaching advantages and learn from fellow teachers' teaching experience and teaching strategies with the help of the visualization-based group awareness tool.

5.4.2. The visualization-based group awareness tool supports reflective learning.

The teachers also commented that viewing the visualization-based group awareness tool on OLSP could support reflective learning for improving performance. As one teacher (WYQ) said, "We can directly see the feedback of each partner on teaching. This makes it easier for us to reflect on and improve our lessons in multiple aspects. I think that's especially good." Another teacher (WLL) mentioned, "With the help of visualization-based group awareness tool, we would not have to analyze so many data by ourselves, greatly reducing the burden and helping reflection." These comments indicated that the visualization-based group awareness tools was useful to reduce teachers' burden of analyzing data and help teachers to reflect in multiple perspectives. Teachers could obtain summarized feedback in a timely way with the support the tool that presented categorized peer comments including the teacher's strengths and the aspects for improvement together with relevant learning resources in a visible format.

Regarding the weakness of the visualization-based group awareness tool and suggestions for improvement, the responses from the participants were focused the problems experienced by them during the study. Some teachers felt that the interface was not user-friendly; they suggested that the group awareness tool could be more specific. Others commented that their computer runs very slow and the network is not good, which influenced the effects of lesson study.

6. Discussion

This study proposed a visualization-based group awareness tool that visualized teachers' individual and group behavior and performance as well as peer comments in a lesson study to facilitate group interaction among teachers. The results have shown promising effected of the approach on improving group interaction and performance in a lesson study in the following aspects.

6.1. Can the visualization-based group awareness tool influence teachers' engagement in social interaction in a lesson study?

In this study, the results suggested that the point centrality of teachers in the experimental group was higher than the comparison group. In other words, teachers in the experimental group were more extensively linked with group members or actively engaged in social interaction than those in the comparison group. One potential explanation is that the Visualization-based Group Awareness Tool could reduce the behavior of social loafing and free riding in computer-based collaborative learning contexts. The social loafing behaviors tend to occur when individual outputs or efforts are not visible or measured in a group situation (Latané, Williams, & Harkins, 1979). The proposed tool could collect the participants' behavioral data and analyze and visualize the engagement intensity of each member, which could help members to monitor and compare individual participation. Therefore, with the help of the group awareness tool, the behaviors and contributions of individual

teachers could be visible, which may stimulate participation and help decrease the social loafing behaviors in the lesson study. The interview results also support this finding. For example, one teacher (DYC) commented that "I think the group awareness tool allows me to see which teachers are involved in and the degree of their participation more clearly. In addition, it can help me to find my own position in this group." This is consistent with the findings of Janssen et al. (2007, 2011) and Jarvela, Veermans, and Leinonen (2008) in that group awareness tools could display the contribution of each member to the group task, therefore and stimulate group members to participate more because of the social evaluation and social comparison factor. Ming et al. (2018) also pointed out that group awareness tool could increase students' behavioral engagement in online collaborative writing, due to it could motivate students to work on the group-writing task through social evaluation and social comparison.

The result is consistent with the finding that the network density of the experimental group is higher than that of the comparison group. Teacher in a high-density network is more in touch with other members in the network than those in a low-density network. Previous social network research also found that the greater the density of the network, the stronger the connection between network members (Otte & Rousseau, 2002).

6.2. Can the visualization-based group awareness tool reduce domination behaviors in social interaction among teachers in a lesson study?

The results indicated that the distance-based cohesion, network density, and network concentration of the experimental group were greater than that of the comparison group, which suggested that the teachers were more strongly tied to each other in the experimental group, and teachers in the experimental group towards the network center were higher than teachers in the comparison group. Compared with the experimental group, there are three more dominant nodes in the social network of teachers in the comparison group, who are the influential senior teachers within the group. According to Saito (2012) and Saito and Atencio (2013), teachers with higher political influence could dominate the lesson studies, whereas novice teachers tend to be reluctant to express their views especially in hierarchical and authoritarian contexts, which is not conducive to creating a more inclusive and meaningful learning community.

In this study, the visualization-based group awareness tool has shown its promising effect on mitigating or eliminating the tendency for influential teachers to dominate the process of lesson study as reflected in the few dominated nodes. One possible reason is that the visualization-based group awareness tool could make individual performance and group interaction more visible, which may help individuals to find appropriate members for interaction in multiple directions. The interview result provides some evidence. As one teacher (ZZL) said that "Through the group awareness tool, I could see peer comments on my lesson summarized in a categorized format and then discuss with different members on different issues." Another teacher (WTT) indicated that the group awareness tool could help her quickly find some expert teachers when she need help.

The result on the network density is consistent with the finding on the network cohesion. Contrast to the comparison group, the network of the experiment group had higher density, and its members were more closely interconnected with less domination behavior. This can be explained by the fact that information could flow more freely among actors in a higher density network than that in a lower density network (Haythornthwaite, 1996).

6.3. Can the visualization-based group awareness tool improve teachers' instructional design performance in a lesson study?

At the beginning of the study, the experimental and comparison groups had no significant differences in their performance scores reflected in their lesson plans. At the end of the study, the

experimental group outperformed the comparison group in learning process design as reflected in their lesson plans.

The positive effects of the visualization-based group awareness tool on improving teachers' performance in learning process design could be explained by its advantage in visualizing interaction behaviors and presenting categorized peer comments on the teacher's strengths and the aspects for improvement together with learning resources in a visible format. As one teacher (WYQ) mentioned that "We can directly see the feedback from each member. This makes it easier for us to reflect on and improve our lessons in multiple aspects. I think that is especially good." Another teacher (GYY) indicated that the visualization-based group awareness tool could help her to find experts and learning resources to address her teaching problems. The finding is consistent with previous studies found that the group awareness tool help learners to improve the performance of group and its members (Bodemer & Dehler, 2011; Buder & Bodemer, 2008; Phielix et al., 2011).

No significant difference was found between the two groups in Front-end analysis and Pedagogies and teaching ideas reflected in the lesson plans. One possible reason is that Front-end analysis and Pedagogies and teaching ideas can't be shown by teaching videos, so teachers didn't pay much attention to it. Further research is needed to investigate this issue.

7. Conclusions

Lesson study provides an opportunity for teachers to improve their knowledge and skills for classroom teaching, where a group of teachers collaboratively research, plan, and observe a series of lessons followed by ongoing discussions and reflections. While social interaction between group members plays an important role in collaborative learning contexts, there are concerns about the quality of group interaction among teachers in a lesson study (e.g. inadequate engagement in discussion, and the process of interaction dominated by a few politically strong teachers). To address these issues, this study proposed a visualization-based group awareness tool that visualized individual and group behavior and performance as well as peer comments to facilitate group interaction in a lesson study implemented on an online platform. Twenty-four primary school teachers participated in the study, and their interaction behaviors and lesson plans were collected for analysis. The results showed positive effects of the visualization-based group awareness tool on enhancing teachers' engagement in social interaction, fostering coherent interaction between members, and improving teachers' performance in learning process design.

The implications of the study are as follows. Visualization of group awareness may take into account two aspects: (a) making individual and group performance and behaviors visible to facilitate social interaction; and (b) presenting categorized peer comments with relevant learning resources in a visible format for effective peer learning. The visualization of individual and group performance and behaviors may facilitate the comparison and regulation of individual performance so as to stimulate active participation and interaction. Making individual performance and group interaction visible may also help individuals to find appropriate peers for interaction in multiple directions, which may lead to coherent interactions instead of being dominated by a few members. Third, visualizing individual and group performance and behaviors as well as presenting peer comments with relevant learning resources in a visible format may help individuals to easily find relevant helpers and useful information for effective learning so as to improve performance.

The study has some limitations. First, the findings from a small number of participants may not be sufficient to generalize the effectiveness of the visualization-based group awareness tool to a broader population. Second, the study was conducted in a local context. There may be cultural influences which limit the generalizability of the findings.

Disclosure statement

Funding

ORCID

Axi Wang 🔟 http://orcid.org/0000-0003-1008-4212

References

Bodemer, D., & Dehler, J. (2011). Group awareness in CSCL environments. *Computers in Human Behavior*, *27*(3), 1043–1045.

Buder, J., & Bodemer, D. (2008). Supporting controversial CSCL discussions with augmented group awareness tools. *International Journal of Computer-supported Collaborative Learning*, *3*(2), 123–139.

Cajkler, W., Wood, P., Norton, J., Pedder, D., & Xu, H. (2015). Teacher perspectives about lesson study in secondary school departments: A collaborative vehicle for professional learning and practice development. *Research Papers in Education*, *30*(2), 192–213.

Dietz-Uhler, B., & Bishop-Clark, C. (2001). The use of computer-mediated communication to enhance subsequent face-to-face discussions. *Computers in Human Behavior*, *17*(3), 269–283.

Dudley, P. (2013). Teacher learning in lesson study: What interaction-level discourse analysis revealed about how teachers utilized imagination, tacit knowledge of teaching and fresh evidence of pupils learning, to develop practice knowledge and so enhance their pupils' learning. *Teaching and Teacher Education*, *34*, 107–121.

Dudley, P. (2016). *Lesson study: Professional learning for our time*. London: Routledge.

Fernandez, C., & Yoshida, M. (2004). *Lesson study: A Japanese approach to improving mathematics teaching and learning*. Mahwah, NJ: Lawrence Erlbaum.

Fransen, J., Kirschner, P. A., & Erkens, G. (2011). Mediating team effectiveness in the context of collaborative learning: The importance of team and task awareness. *Computers in Human Behavior*, *27*(3), 1103–1113.

Gross, T., Stary, C., & Totter, A. (2005). User-centered awareness in computer-supported cooperative work-systems: Structured embedding of findings from social sciences. *International Journal of Human–Computer Interaction*, *18*, 323–360.

Hajar, G., Ahmad, F. M., Abu, D. S., Kamariah, B. A. B., & Maryam, H. (2016). Group awareness in computer-supported collaborative learning environments. *International Education Studies*, *9*(2), 120–131.

Haythornthwaite, C. (1996). Social network analysis: An approach and technique for the study of information exchange. *Library & Information Science Research*, *18*(4), 323–342.

Hsia, L. H., Huang, I., & Hwang, G. J. (2016). Effects of different online peer-feedback approaches on students' performance skills, motivation and self-efficacy in a dance course. *Computers & Education*, *96*, 55–71.

Janssen, J., Erkens, G., & Kanselaar, G. (2007). Visualization of agreement and discussion processes during computer-supported collaborative learning. *Computers in Human Behavior*, *23*(3), 1105–1125.

Janssen, J., Erkens, G., & Kirschner, P. A. (2011). Group awareness tools: It's what you do with it that matters. *Computers in Human Behavior*, *27*(3), 1046–1058.

Jarvela, S., Veermans, M., & Leinonen, P. (2008). Investigating student engagement in computer-supported inquiry: A process-oriented analysis. *Social Psychology of Education*, *11*(3), 299–322.

Jongsawat, N., & Premchaiswadi, W. (2011). A study of two different experimental settings for group awareness information in a web-based group decision support system. *International Journal of Information Technology & Decision Making*, *10*(2), 231–268.

Larssen, D. L. S., Cajkler, W., Mosvold, R., Bjuland, R., Helgevold, N., & Fauskanger, J. (2017). A literature review of lesson study in initial teacher education: Perspectives about learning and observation. *International Journal for Lesson and Learning Studies*, *7*(1), 1–24.

Latané, B., Williams, K., & Harkins, S. (1979). Many hands make light the work: The causes and consequences of social loafing. *Journal of Personality and Social Psychology*, *37*(6), 822–832.

Leavy, A. M., & Hourigan, M. (2016). Using lesson study to support knowledge development in initial teacher education: Insights from early number classrooms. *Teaching and Teacher Education*, *57*, 161–175.

Lee, J. F. K. (2008). A Hong Kong case of lesson study – benefits and concerns. *Teaching and Teacher Education*, *24*(5), 1115–1124.

Lee, J., & Bonk, C. J. (2016). Social network analysis of peer relationships and online interactions in a blended class using blogs. *The Internet and Higher Education*, *28*, 35–44.

Lewis, C. C., Perry, R. R., & Hurd, J. (2004). A deeper look at lesson study. *Educational Leadership*, *61*(5), 18–22.

Liu, C. C., Chen, Y. C., & Tai, S. J. D. (2017). A social network analysis on elementary student engagement in the networked creation community. *Computers & Education*, *115*, 114–125.

Ma, N., Xin, S., & Du, J. Y. (2018). A peer coaching-based professional development approach to improving the learning participation and learning design skills of in-service teachers. *Educational Technology & Society*, *21*(2), 291–304.

Ming, L., Leping, L., & Li, L. (2018). Group awareness increases student engagement in online collaborative writing. *The Internet and Higher Education*, *38*, 1–8.

Otte, E., & Rousseau, R. (2002). Social network analysis: A powerful strategy, also for the information sciences. *Journal of Information Science*, *28*(6), 441–453.

Phielix, C., Prins, F. J., Kirschner, P. A., Erkens, G., & Jaspers, J. (2011). Group awareness of social and cognitive performance in a CSCL environment: Effects of a peer feedback and reflection tool. *Computers in Human Behavior*, *27*(3), 1087–1102.

Rienties, B., Giesbers, B., Tempelaar, D., Lygo-Baker, S., Segers, M., & Gijselaers, W. (2012). The role of scaffolding and motivation in CSCL. *Computers & Education*, *59*(3), 893–906.

Saito, E. (2012). Key issues of lesson study in Japan and the United States: A literature review. *Professional Development in Education*, *38*(5), 777–789.

Saito, E., & Atencio, M. (2013). A conceptual discussion of lesson study from a micro-political perspective: Implications for teacher development and pupil learning. *Teaching and Teacher Education*, *31*(1), 87–95.

Scott, J. (2012). *Social network analysis* (3rd ed.). London: Sage.

Shen, D., Nuankhieo, P., Huang, X., Amelung, C., & Laffey, J. (2008). Using social network analysis to understand sense of community in an online learning environment. *Journal of Educational Computing Research*, *39*(1), 17–36.

Wassermann, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. Cambridge: Cambridge University Press.

Yang, Y. (2009). How a Chinese teacher improved classroom teaching in teaching research group: A case study on Pythagoras theorem teaching in Shanghai. *ZDM*, *41*(3), 279–296.

Yu, S., Yang, X., Cheng, G., & Wang, M. (2015). From learning object to learning cell: A Resource organization model for ubiquitous learning. *Educational Technology & Society*, *18*(2), 206–224.