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Integrating the SOP^2 Model into the Flipped Classroom to Foster Cognitive Presence and Learning Achievements

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ABSTRACT

This study explored student teachers' cognitive presence and learning achievements by integrating the SOP^2 Model in which self-study (S), online group discussion (O) and double-stage presentations (P^2) were implemented in the flipped classroom. The research was conducted at a university in Taiwan with 31 student teachers. Pre- and post-worksheets measuring knowledge of educational issues were administered before and after group discussion. Quantitative content analysis and behavior sequential analysis were used to evaluate cognitive presence, while a paired-samples t-test analyzed learning achievement. The results showed that the participants had the highest proportion of "Exploration," the second largest rate of "Integration," but rarely reached "Resolution." The participants' achievements were greatly enhanced using the SOP^2 Model in terms of the scores of the pre- and post-worksheets. Moreover, the groups with a higher proportion of "Integration" (I) and "Resolution" (R) performed best in the post-worksheets and were also the most progressive groups. Both high- and low-rated groups had significant correlations between the "I" and "R" phases, with "I" → "R" in the low-rated groups but "R" → "I" in the high-rated groups. The instructional design of the SOP^2 Model can be a reference for future pedagogical implementations in the higher educational context.

Keywords

Flipped classroom, CSCL, Cognitive presence, Learning achievements, CoI

Introduction

Many studies have mentioned the potential value of student-centered learning environments in which students engage actively in higher-order thinking tasks, particularly in the higher education context (Davies, Dean, & Ball, 2013; Berrett, 2012; Baepler, Walker, & Driessen, 2014). However, most instructors who are used to delivering lectures might not implement appropriate instructional methods to support student-centered learning (Kim, Kim, Khera, & Getman, 2014). Thus, creating a learner-centered environment still remains a challenge. According to Sahin, Cavlazoglu and Zeytuncu (2015), the flipped classroom model using online videos may increase students' achievement. By previewing flipped materials, students can focus on their individual paces and needs, while in-class activities can be designed to promote higher-order thinking skills (Davies et al., 2013). Echoing flipped principles, our study offered flipped materials, both online video lectures and text-based articles, before class, to help the participants gain proper course knowledge. Research has revealed that computer-supported collaborative learning (CSCL) enables students to learn in groups of four to six by conducting online discussion based on designed tasks for problem-solving resolution (Walker, 2004). Besides, CSCL contexts with online technology support for group work enhances cognitive performance (Resta & Laferrière, 2007). Similarly, a CSCL environment serves as a useful tool for collaborative knowledge construction as a result of students' discussion (Salovaara, 2005). Therefore, knowledge construction among groups could be promoted in CSCL contexts.

In addition to integrating CSCL contexts, researchers have reported that flipped learning enhances learning effectiveness through digital resources, group discussion, oral reports and teacher guidance (Li, Lou, Tseng, & Huang, 2013). It has also been revealed that the flipped classroom design with off-loaded contents, student discussion and presentations, and proper assessment, promotes concept understanding, knowledge application and critical thinking skills (McLaughlin et al., 2014). Moreover, Kong's (2014) digital classroom design enabled learners to apply cognitive knowledge due to online group discussions, teacher feedback and worksheet questions. In fact, it is believed that instructional videos embedded with open-ended questions are effective in learning new content (Enfield, 2013). Thus, it has been suggested that the flipped classroom design adopting digital resources, group-based discussions, oral presentations, feedback sessions and worksheets designed with open-ended questions could foster cognitive development and promote knowledge learning. Accordingly, we propose the SOP^2 Model, where "S" represents the Self-study stage during which each participant previews the flipped materials and completes worksheets, "O" represents the Online group discussion stage during which each group conducts synchronous online discussion in a CSCL context and completes in-class worksheets, and the

double "P" represents the two-stage group Presentations during which each group demonstrates and refines their group reports.

According to the Community of Inquiry (CoI) framework, learning experiences are formed through the interaction of cognitive presence, teaching presence, and social presence (Garrison, Anderson, & Archer, 1999). Researchers have also pointed out that CoI can depict knowledge construction via online collaborative environments in terms of technology assistance, social interaction, and instructional procedures (Shea & Bidjerano, 2010). The designed principles of our proposed SOP^2 model correspond to three major factors: cognitive presence, teaching presence, and social presence from CoI. According to researchers, self-efficacy and metacognition are aspects of self-regulation, which is essential for online learning (Shea et al., 2012). In addition, researchers have suggested that higher-order learning in online environments can be evaluated through cognitive presence (Garrison, Anderson, & Archer, 2001). On the one hand, studying flipped materials prior to class requires much self-regulation and metacognitive learning skills. On the other, open-ended worksheets can assess participants' higher-order learning results. Thus, the design of a "Self-study" stage can help explore the learners' roles in terms of cognitive presence, self-regulation, and metacognition so as to understand how self-learning takes place in the online environment. Next, the "Online group discussion" stage corresponds to social presence in CoI. It is believed that online discussion can facilitate positive emotion, social interaction, and solidarity through emotional expression, open communication, and group cohesion (Shea & Bidjerano, 2010; Garrison et al., 1999). Thus, the design of synchronous online discussion aimed to help participants facilitate collaborative group work via social interaction and communication. Lastly, the "Double-presentation" stage involving group presentations, feedback sessions, and whole-class discussion reflects the spirit of "Teacher presence" in CoI. Garrison et al. (1999) revealed that teacher presence can be shown through three major principles, namely instructional management via organized instructional design, building understanding via personal or group sharing, and direct instruction via explanation or clarification by instructors. Similarly, the "Double-presentation" design consists of standardized instructional procedures with clear goals and learning contexts, group sharing of knowledge with feedback sessions, and whole-class discussion along with teacher-led summaries and explanations based on the group presentations.

Regarding the importance of the SOP^2 model, the online video-lectures offered during the self-study stage can improve students' problem solving preparation and efficiency since the flipped materials could prompt them to revisit the videos to seek and answer relevant questions during problem-solving activities (Tawfik & Lilly, 2015). Next, the synchronous online discussion stage was especially designed to allow participants to share and reflect on ideas without time and space limitations, as well as to learn from multiple perspectives to construct knowledge through interactive discourse (Lipponen, 2002). Similarly, Branon and Essex (2001) claimed that instant interaction in synchronous communication can facilitate knowledge sharing and feedback. Moreover, since the participants were required to conduct online discussion based on educational problem-solving contexts, it was discovered that synchronous discussion could enhance their decision-making and brainstorming skills (Branon & Essex, 2001) which are important abilities for problem-solving contexts. In addition, another study showed that learners' problem-solving skills can be reinforced using synchronous computer-supported collaborative learning tools (Lazakidou & Retalis 2010). As for the presentation feedback and revision stages, a previous study suggested that whole-class discussions and oral peer assessments enable participants to increase their reflection on new situations as well as promoting self-assessment and awareness (Topping, 2009). Moreover, teacher feedback can assist learners in clarifying goals, enhancing commitment, and increasing their learning efforts (Hattie & Timperley, 2007).

Cognitive presence describes the process of community inquiry into a problem (Garrison, Anderson, & Archer, 2001). Garrison and colleagues (2001) measured cognitive presence in terms of the Practical Inquiry Model to evaluate the quality of online discourse. The PI Model consists of four cognitive phases, namely Triggering events, Exploration, Integration, and Resolution (Garrison & Anderson, 2003). Since this model is considered to be an effective tool for evaluating cognitive presence and higher-order learning (Schrire, 2006; Akyol & Garrison, 2011), in the present study, we have adopted it to analyze online discourse to gain an understanding of the participants' level of cognitive presence. Akyol and Garrison's (2011) study indicated that online collaborative development of cognitive presence is linked with actual learning grades. Thus, we also evaluated our participants' course-specific knowledge based on their individual worksheet scores in order to understand how the implementation of the SOP^2 Model affected their learning achievements. The following research questions were thus formulated: (1) How does integrating the SOP^2 Model in the flipped classroom influence the student teachers' cognitive presence? (2) How does integrating the SOP^2 Model in the flipped classroom influence the student teachers' learning achievements? (3) In what way does cognitive presence relate to the learning achievements of the groups using our proposed model?

Method

Our study applied both quantitative and qualitative methods to investigate participants' cognitive presence and learning performance. Online discourse analysis using the PI Model was used to explore cognitive presence, while individual worksheet scores were used for the evaluation of students' learning achievements. In addition, student interviews were adopted as qualitative data to gain deeper understanding of our developed model. Integrating the SOP^2 Model in the flipped classroom was the independent variable. The first research question investigated the four categories of cognitive presence, the second explored learning achievements based on the scores of individual worksheets, while the third explored the relationship between cognitive presence and learning achievements of the groups. See Figure 1 for our research design structure.

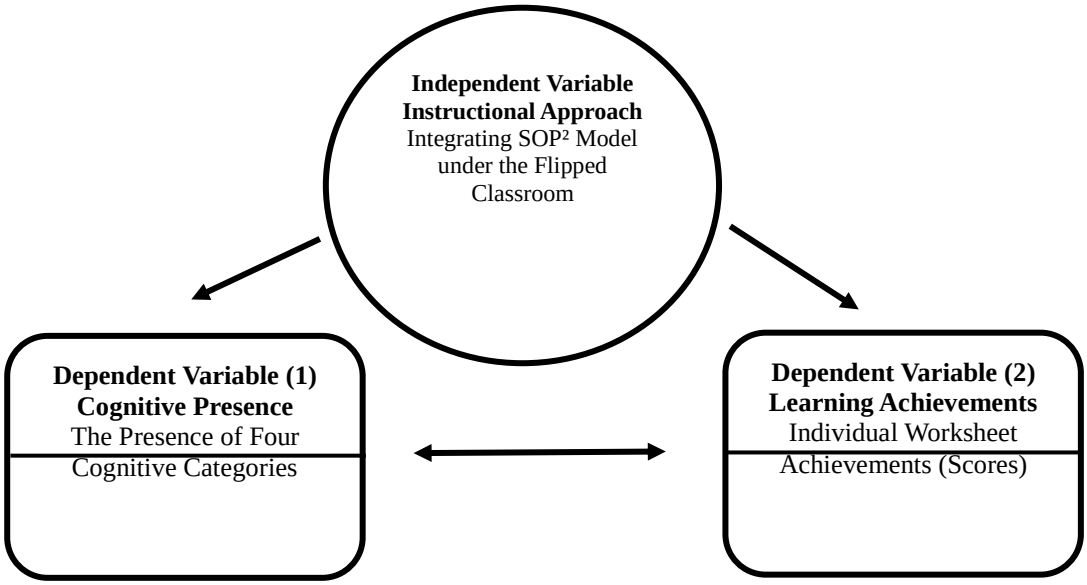

Figure 1. The research design structure

Participants

This study was conducted using an eighteen-week course, "Introduction to Education" as the research context. The participants attended this course at a university in Taiwan in 2015. One instructor with 13 years of teaching experience, two teaching assistants, and 31 student teachers (23 undergraduates and 8 graduates) were involved. These student teachers were enrolled in a secondary teacher education program. The participants were assigned to groups of four, except for one group of three, with eight groups in total.

Instructional contexts and procedures

There were three cycles of SOP^2 sessions in the flipped classroom throughout the semester, and the format of each was the same. Our research design was based on a specific course plan. The course requirements were introduced in the first week. For the following two weeks, education theories were introduced during face-to-face classes. Meanwhile, grouping was conducted by mixing the participants with low, medium, and high critical thinking dispositions based on "The Inventory of Belief and Critical Thinking Disposition" (Yeh, 1999). Moreover, an ice-breaker activity was conducted to increase familiarity among group members. Online discussion skills were introduced and techniques for operating the TMOF system were demonstrated in the fourth class.

Self-study stage

The participants had one week to preview the flipped materials at home before attending each class session. The materials, including online videos with PPTs, audio recording, and relevant articles, were uploaded to the online system. They were carefully designed and arranged by the instructor and the research team based on current educational issues. There were three issues in total which combined theories from psychology, sociology,

philosophy and administration of education, curriculum design and development, teaching techniques and strategies, class management, as well as youth counseling and guidance. See Table 1 for detailed descriptions of the three educational issues, the discussed topics, and relevant theories. Students could download the flipped materials through the online system to gain preliminary knowledge and understanding of the issues. Besides, each participant was required to explore the answers from the selected materials and complete an individual "Flipped Classroom Worksheet" with five open-ended questions. The participants had one week to read the materials and submit the individual worksheet through the online system.

Table 1. Three educational issues, discussed topics and related theories

Educational issue	Issue 1 : The Development of Twelve-year Compulsory Education	Issue 2: The Challenge of Technology Integration into Instruction	Issue 3: The Predicament of Neo Children in Taiwan
Discussed Topics	1.Learning motivations 2.Social Service 3.Differentiated teaching 4.Course integration 5.Teacher profession	1. Internet addiction 2. Digital gap 3. Social Network 4. Technology integration 5. Information literacy	1. Difficulties of neo children 2. Classroom adaptation 3. Negative behavior in teenagers 4. Classroom strategy 5. Monster parents
Theories Included	• Psychology of education • Sociology of education • Teaching techniques and strategies • Course design and development • Administration of education	• Philosophy of education • Psychology of education • Sociology of education • Course design and development • Teaching techniques and strategies	• Sociology of education • Psychology of education • Youth counseling and guidance • Class management • - Administration of education

Online group discussion stage

CSCL contexts were designed for the synchronous class time. The student teachers had their own computers and synchronously communicated with their group members through the TMOF system. Prior to online group discussion, the participants were required to prepare for the upcoming events. Also, face-to-face interaction was permitted before the CSCL contexts to establish ground rules for the online discussion. As a warm-up session, face-to-face interaction took place prior to the online discussion stage. Each group then conducted collaborative online discussion for 70 minutes via the online system, using chat forum, tree map, and other chatting tools. Each group presented, exchanged ideas, and constructed a shared tree map of their group discussion results. The instructor and two teaching assistants monitored and facilitated eight groups at a time by answering questions or solving technical problems. At the end of the group discussion, an individual "In-class Worksheet" with five open-ended questions was issued through the TMOF system. Each participant answered the assigned questions and referred to the information from the discussion forum or tree map outcomes. This stage lasted around 30 minutes

Double-presentation stage

This stage came after each online stage ended. Each group organized their text-based discourse and tree map results based on the three assigned topics. Each of the eight groups presented their group report in the form of PPTs and demonstrated their 1st stage group presentation (6 minutes), focusing on sharing general knowledge. They received written and oral feedback from the instructor and peers before refining their 2nd stage group presentation (8 minutes), focusing on exploring the comprehensive knowledge in more depth. The feedback sessions enabled the participants to offer reflective and concrete comments based on the presentations. Individual worksheets and group reports were completed and submitted through the online system. Teacher announcements and e-mails were sent to remind the participants of upcoming events, class updates, and assignments. Figure 2 shows the cycle of instructional procedures in the SOP^2 Model.

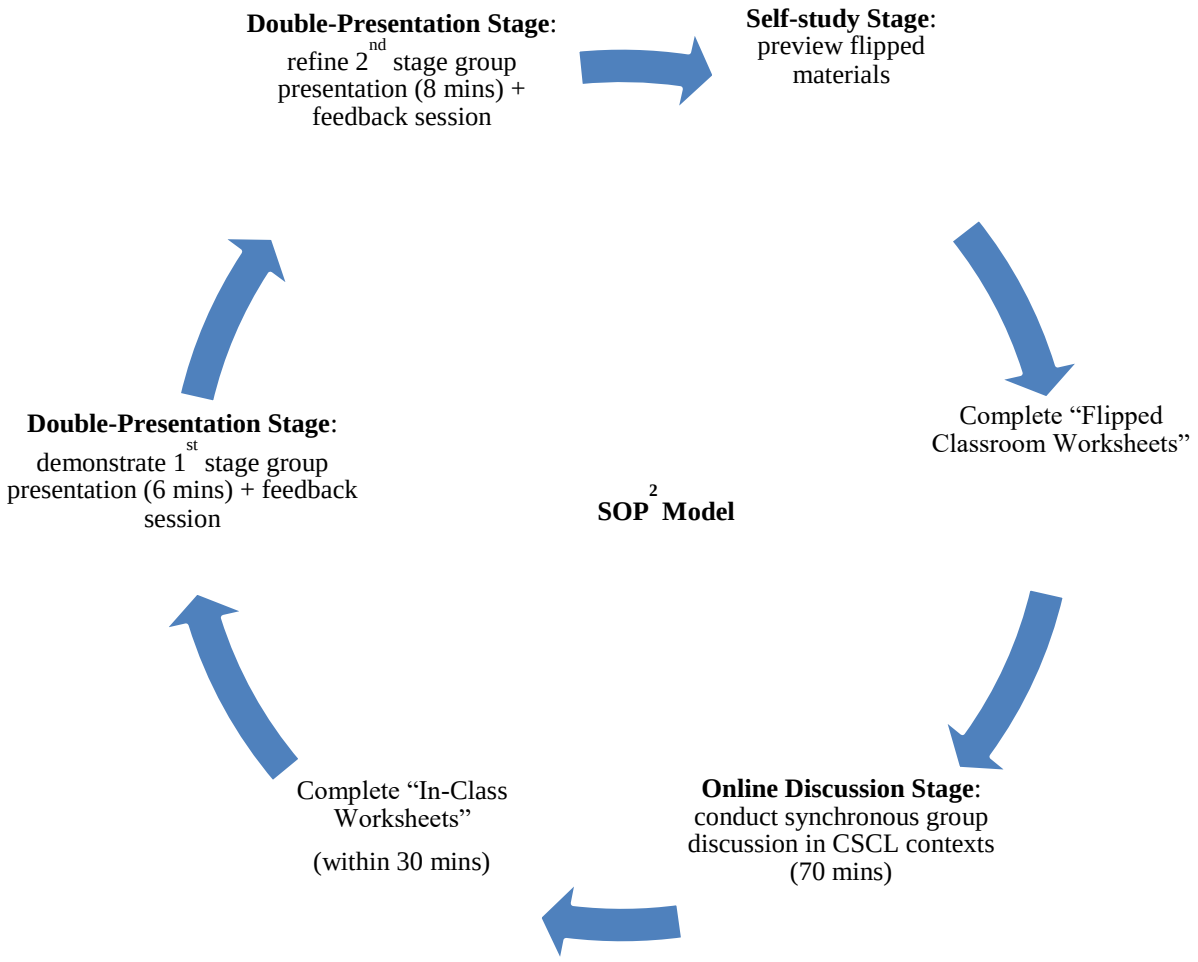

Figure 2. Cycle of instructional procedures in the SOP^2 Model

Instruments

Online discourse analysis and coding examples

Synchronous online discussions were collected for discourse analysis. Our coding instrument for evaluating the quality of cognitive presence was based on the PI model, which comprises four cognitive categories: (1) Triggering events (category T), (2) Exploration (category E), (3) Integration (category I), and (4) Resolution (category R). Each coded unit is "a meaningful message" (Kanuka, Rourke & Laflamme, 2007; Vaughan & Garrison, 2005). Each meaningful message is made up of a sentence or sentences with a definite idea or clear intention. For example, the context for educational issue one describes: "Cheng is a junior-high school student who usually falls asleep during class time and has difficulty concentrating on his studies." One student from group 5 stated at the very beginning of the group discussion, "According to the context, he already lacked learning motivation." This sentence shows a clear message with an attempt to present background information for the educational context. Online discourses were coded based on relative keywords associated with the definitions and indicators of the four cognitive categories proposed by Garrison and colleagues (2001, p. 17-20), while the other messages belong to others (category O). Each participant had their own code, where A to H represents the 8 groups and 1 to 4 represents the group members. Thus, the first member of group 1 was coded A1. Every meaningful message was counted once under each category. Quantitative content analysis was adopted to count the frequency for each category and the distribution over the four cognitive phases. Sequential behavior analysis was also adopted to explore whether a behavioral sequence of one discussion behavior followed by another was significant (Hou & Wu, 2011). Example discussion messages from the four cognitive phases are presented in Table 2.

Table 2. Example discussion messages of the four cognitive phases

Triggering events (category T)	
Example discussion messages	
(Lead direction) Start from Q2: The cause and influence of digital gap	(A1 participant)
(Ask question) Does anybody know individualized learning?	(E1 participant)
(Lead new direction) I believe it is hard to separate Q1 into positive and negative aspects. What is your opinion?	(B2 participant)
(Pose question) I have no idea how to analyze Q2 using theories from psychology of education ...	(B1 participant)
(Present background information) According to the context, he already lacked learning motivation...	(E2 participant)
Exploration (category E)	
Example discussion messages	
(Contradictory viewpoints)	
Do we have to list out the reasons for students' distractions?	(B2 participant)
But I divided into sensing problems and parent cooperation.	(B1participant)
(Personal descriptions)	
When I was in senior high school, we were not allowed to use cellphones.	(E1 participant)
(**Divergent viewpoints)** Is multicultural education different from teaching adjustment?	(D2 participant)
(Unsupporting addition)	
Even though there is Internet regulation, no one can monitor the students.	
(E2 participant)	
(Personal opinions) Content design should motivate students' learning interest and turn into internal learning motivations.	(A1participant)
Integration (category I)	
Example discussion messages	
(Connect ideas) I'm restating the educational differences between Finland and Taiwan; Finland is more focused on (1) individualized teaching and learning; (2) adjustable teaching approach; (3) adjustable assessments.	(D1 participant)
(Build on the idea) Teachers of the same grade can exchange teaching approaches, communicate more frequently, inspire teaching strategies...Teachers should be required to take professional courses so they can work with teachers teaching different grades.	(A3 participant)
(Offer relevant source) Based on the definition in the materials, "information literacy" means: Knowing when he/she needs the information and his/her ability to search, evaluate, and use the information.	(E2 participant)
(Integrate relevant source) Volunteers can be motivated by their peers. Reference: http: //www.epochtimes.com/b5/15/3/19/n4391081.htm	(F3 participant)
(Create possible solutions) Utilizing online contest system for students to make up questions and have others answer them, in order to enhance motivation and competitiveness.	(A3 participant)
Resolution (category R)	
Example discussion messages	
(Comprehensive solution) Assessment can include school grades, students' diary, worksheets, research and data collection, presentation skills, observations as well as interviews to evaluate students' learning progress.	(B4 participant)
(Evaluate the solution) Helping students find their interest is a good point, but setting higher goals for them needs further evaluation of their learning ability.	(B2 participant)
(Test the solution) It is good to explore his strengths and give him a sense of achievement; meanwhile, we need to acknowledge his peer relationship. It is win-win if handled well, otherwise it is lose-lose.	(B2 participant)
(Alternative solution) This activity can also be applied to Q5, which concerns how to lessen bullying and cliques. This approach helped them learn to accept different ideas of individuality.	(B2 participant)
Other (category O)	
Example discussion messages	
(Monitor discussion situation) Any other opinions? Or we can move on to the next	(E1 participant)
(Remind time) We had better hurry up. We had two more	(D2 participant)
(Distribute tasks) We pick one person to draw the tree map and other members can express their opinions	(E1 participant)
(Express agreement) You are great! I'll give you a "like".	(B2 participant)
(Greeting) Hello! Good afternoon everyone!	(D1 participant)

Individual worksheets

The "Flipped Classroom Worksheet" was considered as the "Pre-worksheet," while the "In-class worksheet" was the "Post-worksheet." The worksheets and rubrics were designed by our research team and scrutinized by an expert with more than ten years of teaching experience in a teacher education program. The pre- and post-worksheets consisted of five open-ended questions regarding the educational topics and related theories with the purpose of measuring the students' learning achievements. The questions are literally the same with slight structural differences between the two worksheets (see the Flipped Classroom Worksheet example in Figure 3 and the In-class Worksheet example in Figure 4). The rubric for grading individual worksheets is provided in Table 3. To validate the worksheet contents, preliminary analysis of the correlation between the pre- and post-worksheets was performed. Table 4 shows that pre-worksheets regarding issue 1, 2, and 3 had significant correlations with their post-worksheets, showing $p < .05$, $p < .01$, and $p < .001$, respectively.

Table 3. The rubric for individual worksheets

Rubrics	Rating
(1) Each individual worksheet contains five open-ended questions	Maximum 20 points for each question
(2) Offer logical and corresponding answers to the questions	10 points for each question
(3) List the answers by bullet points: higher scores for more listed items	a. 1 point for each listed item b. 1 extra point for each listed item with rich contents
(4) None of these three conditions gets any points: a. Directly copy and paste all the information b. Offer irrelevant answers c. Simply answer "Yes" or "No"	0 points for any of these three conditions

Q1. (1) Please list out at least three points after watching the video on educational views from Finland; (2) Please point out a concept or a sentence you are most impressed with in the video regarding learning motivation. Please explain how you can increase students' learning motivation.
Q2. Please explain the impacts of social services and elaborate the value and meaning of social services.
Q3. (1) According to the video clip, please explain the features of a learning community; (2) Please elaborate how teachers can implement differentiated instruction to decrease students' proficiency gap.
Q4. What principles should be included in course design? Please explain in detail.
Q5. What are the difficulties with the "Twelve-year Compulsory Education" policy? Please list out relevant solutions for the proposed difficulties.

Figure 3. Flipped classroom worksheet example

Q1. Learning motivation can determine students' learning efficiency. Please elaborate methods for improving learning motivation.
Q2. What are the influences of social services? Please discuss the value and meaning of social services.
Q3. Due to diverse social structures, there is an increasing learning gap among students. Please elaborate instructional methods for differentiated learning.
Q4. Please elaborate how to arrange and design courses so as to meet students' learning needs.
Q5. In your opinion, what are the problems triggered by the "Twelve-year Compulsory Education" policy? Please explain possible solutions for the problems.

Figure 4. In-class worksheet example

Table 4. Correlation between pre- & post-worksheets

Individual worksheet		*N*	Correlation	*p*
Issue1	Pre & post worksheets	31	.383	.033*
Issue2	Pre & post worksheets	30	.479	.007**
Issue3	Pre & post worksheets	31	.589	.000***

Note. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Each participant's two achievement scores from the pre- and post-worksheets were evaluated by dependent *t*-test to investigate learning achievement. Two raters reached a compromise concerning the rubrics before actual grading. Around 20 worksheets were randomly picked for an inter-rater reliability test. The correlation coefficient agreement between the two raters reached .965 ($p = .000$), indicating high reliability. To answer in

what ways cognitive presence relates to learning achievements among groups, we compared the results of cognitive presence and worksheet performance of the eight groups. Pearson Product Moment correlation was operationalized to analyze how the achievement scores were associated with the cognitive presence of the groups.

Results and discussion

Cognitive presence

A total of 1,134 units of "meaningful message" were coded. Of these, 114 (10%) were randomly selected to conduct Kappa coefficient analysis. The kappa value was .806 which reached the .000 level of significance between the two raters. Regarding the frequency and distribution of the cognitive categories, overall class discussions demonstrated that the largest proportion is category "E" (n = 408; 36.0%), the second largest is category "I" (n = 257; 22.7%), the third is category "T" (n = 235; 20.7%), the fourth is category "O" (n = 199; 17.5%), and the lowest proportion is Category "R" (n = 35; 3.1%) (see Table 5).

Table 5. Cognitive category frequency distribution for the whole class

Group/ Category	G1	G2	G3	G4	G5	G6	G7	G8	All
T	*N*	17	43	3	29	90	15	27	11
	%	12.2%	25.6%	4.1%	18.8%	31.8%	13.6%	26.2%	10.7%
E	*N*	70	46	15	55	105	37	20	60
	%	50.4%	27.4%	20.3%	35.7%	37.1%	33.6%	19.4%	58.3%
I	*N*	42	29	18	31	48	40	26	23
	%	30.2%	17.3%	24.3%	20.1%	17.0%	36.4%	25.2%	22.3%
R	*N*	5	8	6	5	0	7	5	1
	%	2.2%	4.8%	8.1%	3.2%	0%	6.4%	4.9%	1.0%
O	*N*	7	42	32	34	40	11	25	8
	N	139	168	74	154	283	110	103	103
All	%	100%	100%	100%	100%	100%	100%	100%	100%

Comparing the frequency and distribution of the eight groups, five (G1, 2, 4, 5, 8) had the highest proportion of category "E," while the other three fell into different categories. Four groups (G1, 3, 7, 8) had the second highest proportion of category "I." The proportion of the category of "Resolution" was relatively low, with no more than 8.1% among the eight groups; one group (G5) had no coded discussion in the "R" phase. The distribution of category "O" varied among the eight groups. The highest percentage was 43%, whereas the lowest was 5%. The percentage of category "T" also showed little difference among groups, with the highest percentage nearly 32%, and the lowest around 4%. See the distribution of cognitive categories for the whole class in Figure 5.

The results indicate that both the whole class and individual groups had the highest frequency of exploring or sharing different opinions and experiences. The "Exploration" phase dominating cognitive presence is consistent with previous studies (Kanuka, Rourke, & Laflamme, 2007; Vaughan & Garrison, 2005; Garrison et al., 2001). The second most frequent discussion behavior for the whole class and among groups was "Integration," during which the students attempted to connect or extend other members' ideas and create possible solutions. Although the results showed that "Integration" is the second most active phase, compared to previous research (Kanuka et al., 2007; Vaughan & Garrison, 2005; Meyer, 2003) which showed a drastic reduction in this phase, the distribution rate of "Integration" in our study is rather high among the four categories of cognitive presence. Additionally, according to our student interviews, numerous participants revealed that our instructional approach enabled them to reach the "Integration" level by connecting, synthesizing solutions and further constructing educational knowledge.

Lastly, the "Resolution" phase rarely occurred, having the lowest proportion during synchronous group discussions both in the whole class and among groups. A number of students claimed that the online discussion duration was too short for thorough discussions. According to Akyol and Garrison (2011), lack of time hinders the "Resolution" phase since students do not have sufficient time to share their application results. Moreover, based on the student interviews, owing to their lack of teaching experience, the participants could only discuss the topics in terms of the theories introduced in the flipped materials and they had difficulty offering concrete resolutions. In fact, we found that 11 of the 31 participants, around 1/3, reported that they did not have any hands-on teaching experience.

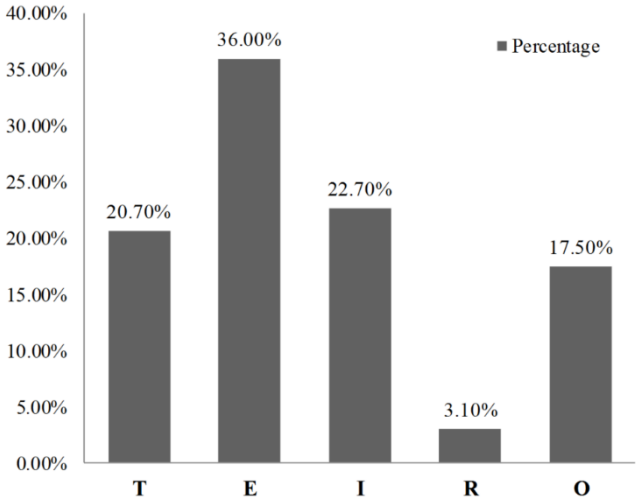

Figure 5. Cognitive category distribution for the whole class

> *Participant (G1): I learned to search for and integrate the information but failed to reach the self-reflection level. Some members had no teaching experience, so they didn't understand the importance of the issue.*
> *Participant (F1): Some topics need the teachers' classroom management skills, but my group members didn't have much teaching experience, so we had to spend more time thinking.*

In fact, according to Garrison and colleagues (2001), reaching the "Resolution" phase requires clear expectations and opportunities so as to apply created knowledge. In other words, since some of the student teachers had no teaching experience, their discussions remained at the "Integration" level and failed to connect with the actual teaching environment, let alone to apply what they had learned to the teaching job.

Learning achievements

The Cronbach's alpha value reached high reliability among the three sets of pre- and post-worksheets, reaching .858 and .843, respectively. A total of 24 worksheets were randomly picked to evaluate the inter-rater reliability. The correlation coefficients reached .965 (p = .000), indicating high reliability. Based on the three respective educational issues, as shown in Table 6, the participants made significant improvement from the pre- to the post-worksheets for educational issues 1, 2, and 3 with $p < .01$, $p < .001$, and $p < .01$, respectively.

Table 6. Paired-sample *t*-test between pre- and post-worksheets

Individual worksheet		Mean	*N*	*SD*	*t*	*p*
Issue1	Flipped classroom (Pre)	42.6129	31	5.28316	-3.887	.001**
	In-class (Post)	47.0645	31	6.12609		
Issue 2	Flipped classroom (Pre)	42.8667	30	6.42588	-4.405	.000***
	In-class (Post)	48.9667	30	8.15151		
Issue 3	Flipped classroom (Pre)	43.8710	31	6.68203	-3.567	.001**
	In-class (Post)	47.6452	31	6.30105		

Note. $^{**}p < .01$, $^{***}p < .001$.

Paired-samples *t*-tests were performed to investigate the overall learning achievements by integrating online group discussion in the flipped classroom context. Table 7 shows that the participants' overall learning achievements made significant progress from the pre- to post-worksheets ($p < .001$).

Table 7. Paired-sample *t*-test between pre- & post-worksheets

	Individual Worksheet	*N*	Mean	*SD*	*t*	*p*
Issue1.2.3	Flipped classroom (pre)	30	129.50	16.77591	-4.821	.000***
	Online (Post)	30	143.23	18.08540		

Note. $^{***}p < .001$.

The paired-samples *t*-test results showed that the student teachers improved significantly in terms of their learning achievements as a result of integrating the SOP[2] Model. According to the student interviews, the online

discussions helped facilitate the exchange of multiple opinions as well as connect ideas from different members' perspectives, so the completeness and broadness of the discussions were reinforced. Additionally, many students revealed that the online discussion activities enhanced the organization of the group discourse because proposed opinions and suggestions could be integrated into complete answers for the discussed topics. In this case, the student teachers' learning achievements could be greatly improved when integrating the SOP^2 Model into the flipped classroom. The results are consistent with the previous study that group collaborative activities in web-based courses can significantly improve grades (Benbunan-Fich & Arbaugh, 2006).

> *Participant (D1): Group discussion helped me understand the opinions of other group members. I had opportunities to view the issue from different perspectives...the discussion results became broader and more complete.*
> *Participant (D3): Basically every member's opinions and suggestions were induced, and the discussion results combined the ideas from all the other members.*

Cognitive presence and learning achievements

Further comparison of learning achievements was conducted among the eight groups. Based on the post-worksheet performance and the discrepancy score, Table 8 shows that the three highest rated groups were groups 1, 3, and 6, categorized as the "High-achievement groups," while the three lowest rated groups, groups 4, 5, and 8, were categorized as the "Low-achievement groups."

Table 8. Pre- and post-worksheet performance between groups

Group	Flipped classroom (3 Pre-worksheets in total)	In-class (3 Post-worksheets in total)	Score of discrepancy
1	138.00	161.33	23.00
3	132.25	156.25	24.00
6	129.50	155.00	25.50
2	126.50	149.75	23.25
7	129.50	145.75	16.25
4	133.00	129.33	- 3.66
8	125.50	128.50	3.00
5	124.50	121.00	- 3.50
Total	129.50	143.23	13.73

In terms of the correlation between the percentage (%) of cognitive categories and learning achievements (see Table 9), there was no significant correlation between categories "T," "E," and "O" and the learning achievements of the eight groups. However, it was notable that category "I" correlated significantly with the post-worksheets (Pearson = .655; p = .039), indicating that the groups with a higher proportion of category "I" had better performance on the post-worksheets

Table 9 also shows that the "Resolution" phase had significant correlation with the post-worksheets (Pearson = .695; p = .028) for the eight groups. We discovered that the higher the proportion of "Resolution", the better performance on the post-worksheets. In addition, there was also a significant correlation between category "R" and the score of discrepancy (Pearson = .727; p = .02). That is, the groups with a higher rate of "Resolution" were also the most progressive groups. Quantitative content analysis was performed to further compare the differences between the high- and low-achievement groups. Table 10 shows the frequency distribution of cognitive categories for the high- and low-achievement groups. The high-achievement groups had 1.5 times (31%) the proportion of category "I" than the low-rated groups (19%). That is to say, the high-achievement groups had more frequent integrated messages and were more likely to develop concrete solutions for the discussed issues. Although the low-rated groups had around double the "Triggering events" of the high-rated groups, codes of "Resolution" in the high-rated groups occurred 2.5 times (frequency = 16) more than in the low-rated groups (frequency = 6). In other words, the high-rated groups were more inclined to create comprehensive resolutions and further apply possible solutions. For the category of "Exploration," the high- and low-rated groups reached similar distributions, with 38% and 41% respectively. Meanwhile, the two groups had the same proportion (15%) of category "O."

Table 9. Correlation between cognitive presence and learning achievements

	Category (%)	Pre-worksheets	Post-worksheets	Score of discrepancy
T (%)	Pearson correlation	-.499	-.483	-.393
	p	.104	.113	.168
	N	8	8	8
E (%)	Pearson correlation	.026	-.290	-3.56
	p	.475	.243	.193
	N	8	8	8
I (%)	Pearson correlation	.489	.655*	.597
	p	.110	.039	.059
	N	8	8	8
R (%)	Pearson correlation	.270	.695*	.727*
	p	.259	.028	.020
	N	8	8	8
O (%)	Pearson correlation	.025	.182	.210
	p	.476	.333	.309
	N	8	8	8

Note. $^{*}p < .05$.

Table 10. Cognitive distribution of high- and low-achievement groups

		T	E	I	R	O	Total
High-achievement groups (*n* = 3)	Frequency	35	122	100	16	50	323
	Percentage	11%	38%	31%	5%	15%	100%
Low-achievement	Frequency	130	220	102	6	82	540
	Percentage	24%	41%	19%	1%	15%	100%

Sequential analysis was also conducted to understand the differences in the behavioral patterns of the high- and low-rated groups. The sequential analysis of coded discussions in the high- and low-achievement groups is shown in the adjusted residuals table (see Table 11), in which each row represents a starting behavior and each column represents a follow-up behavior (Hou & Wu, 2011). If a Z-score is greater than 1.96, the sequence of a row and a column is statistically significant ($p < .05$) (Bakeman & Gottman, 1997). All the significant sequences in the high- and low-achievement groups are shown as behavioral transition diagrams in Figure 6.

The sequential analysis explores the differences in the behavioral patterns of knowledge construction of the high- and low-rated groups. Figure 6 indicates that their sequential behavior patterns were similar. Table 11 shows that both groups had six significant sequences with Z-scores greater than 1.96. In addition, both groups had significant sequences within its own dimension for categories "T," "E," "I," "R" and "O" (i.e., "T" → "T"; "E" → "E"; "I" → "I"; "R" → "R"; "O" → "O"). While categories "T," "E" and "O" were all independent from the other four dimensions, categories "I" and "R" were significantly correlated with each other in both groups. However, the high- and low-rated groups had different directional sequences between categories "I" and "R." The slightly different sequences were "R" → "I" for the high-achievement groups, but "I" → "R" for the low-achievement groups. This finding indicates that while the low-rated groups gradually formed comprehensive resolutions from the integration phase, the high-rated groups paid more attention to integrating the concrete resolutions once they were raised.

The proportion of the "Integration" and "Resolution" categories correlated significantly with the participants' learning achievements. The groups with a higher proportion of the "Integration" phase had better post-worksheet performance. The groups with a higher rate of the "Resolution" phase also did better on the post-worksheets and were the most progressive groups based on the discrepancy score. Regarding quantitative content analysis, the high-rated groups outperformed the low-rated groups in the "Integration" and "Resolution" phases during knowledge construction, while triggering events, exploration of knowledge, and off-topic discussions had no direct impact on learning achievements. The "Integration" and "Resolution" phases are considered to be higher levels of cognitive presence (Garrison et al., 2001), and higher cognitive presence in collaborative online discussion environments is linked with actual learning grades (Akyol & Garrison, 2011). Thus, our results are consistent with previous findings, which showed that higher-rated groups with larger distribution in the "Integration" and "Resolution" stages have better learning achievements. Based on the student interviews, the high-rated groups (G3&6) were already well prepared with relevant information and answers before the class sessions. Thus, it can be inferred that the high-achievement groups were more likely to achieve the "Integration"

and “Resolution” phases during the group discussions. In addition, all members were already assigned specific tasks before the online discussion.

Table 11. Sequential behaviors of high- and low- achievement groups

	Z-score	T	E	I	R	O
High-achievement groups	T	3.17*	-1.48	-1.81	1.91	0.46
	E	-2.97	5.33*	0.71	-3.22	-3.64
	I	-0.16	-1.09	2.45*	0.06	-1.60
	R	-0.58	-2.17	2.21*	3.77*	-1.72
	O	1.84	-3.19	-3.86	0.35	7.55*
Low-achievement groups	T	3.95*	-0.46	-3.00	-1.39	-0.39
	E	-4.08	6.94*	-0.40	-2.05	-3.64
	I	0.71	-4.13	4.73*	3.02*	-1.25
	R	-1.26	-0.96	1.20	8.31*	-0.94
	O	0.44	-4.21	-1.35	-1.04	7.09*

Note. $^{*}p < .05$.

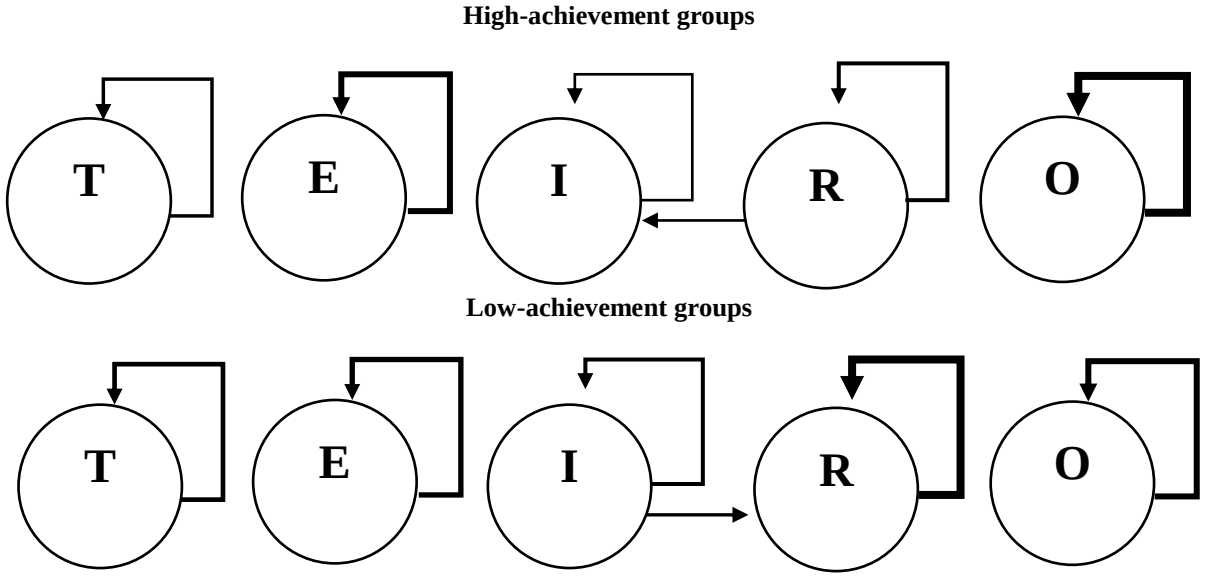

Figure 6. Behavioral diagrams of high and low-achievement groups

With respect to the sequential analysis of behaviors, the results showed no sequential correlation among the categories “T,” “E,” and “O” in either group, while two groups demonstrated significant correlations between the integration and resolution phases, whose sequential behavior could be an essential factor in the collaborative group discussion. The slight disparity lies in the different directional sequence between categories “I” and “R”, which resulted in high and low achievements.

Researcher: How did you keep your discussion focused?
Participant (F2): All the members were active and brought their own information to the discussion. I personally prepared a lot of stuff for discussion....we took turns sharing the ideas we had prepared in advance.
Researcher: Do you mean you had all the answers and information written down for the discussion?
Participant (C2): Yes. Every member did so and we had already organized our own answers. In fact, we even finished distributing tasks before the discussion activity.

By observing the online discourse patterns of the high-rated groups (G3&6), it is indicated that they integrated or organized the comprehensive resolutions all over again after each one was developed. Thus, the pattern showed a significant correlation from the “R” to “I” categories. In contrast, we discovered that the low-rated groups (G5&8) posted all the information and ideas on the system without careful organization, which is demonstrated in the following comments from the excerpts of interviews with the low-rated groups.

Participant (E1): The online system was not helpful...we didn't exchange information...all the members posted their information and one member took charge of integrating all the results.
Participant (H3): Many discourses were unorganized because all the members posted their opinions on the system...there was no information exchange at all.

Since higher cognitive presence such as in the "Integration" and "Resolution" phases is connected with actual learning performance in collaborative online discussion environments (Akyol & Garrison, 2011; Garrison et al., 2001), judging from our study results, the high-rated groups had a higher proportion of activity in the "Integration" and "Resolution" stages, and thus they were more likely to gain better learning grades. A further analysis on the student interviews indicated that the high-rated groups had better preparation of available resources and possible answers to reach resolutions for the educational contexts. In addition, the student interviews revealed that the high-rated groups conducted task distribution before the discussion activities. It has been revealed that role assignment could increase peer interactions and contribute to a higher level of cognitive presence and knowledge construction (Bliss & Lawrence, 2009; DeWever et al., 2010; Gašević et al., 2015) Therefore, due to the limited discussion time, it was more possible for the high-rated groups to reach the "Integration" and "Resolution" phases during group discussions. In addition, according to Mayordomo and Onrubia (2015), group organization and coordination are factors that distinguish high and low group performance during collaborative knowledge construction. Thus, by observing the online discourse, the sequential behavioral patterns suggested that the high-achievement groups, with a significant sequence from "Resolution" to "Integration," tended to summarize or organize the proposed resolutions all over again at the end of the group discussion, while the low-achievement groups simply provided information and unorganized ideas without any final re-organization.

Student perceptions on the SOP^2 model

Self-studying flipped materials increased motivation and triggered problem-solving (Triggering Event): Most participants claimed that the flipped materials triggered their interest in the discussion topics and drove them to search for relevant information from other resources in order to clarify questions related to the problem-solving context, if they failed to understand the ideas from the flipped materials.

Researcher: Do you mean you searched for additional resources?
Participant (A1): Yes, I believe the flipped materials served as a triggering point.
Participant (F1): After reading the flipped materials, I knew what other information was needed to solve the problems in the educational contexts.

Online group discussion facilitated exploration of different opinions and knowledge exchange (Exploration): Many students claimed that online group discussion assisted them in exploring and exchanging different perspectives and opinions with other group members, and thus the depth and completeness of their group discussions were reinforced.

Researcher: Do you think group discussion is an important instructional design?
Participant (D1): I believe group discussion helped me understand opinions from other group members. I had opportunities to view the issue from different perspectives... the discussion became broader and more complete.

Online discussion and the worksheet design reinforced idea connection and knowledge construction (Integration): Numerous students revealed that the online discussion helped connect and integrate diverse opinions, draw conclusions for the discussion outcomes, and achieve knowledge construction for the educational contexts. In addition, many other students revealed that the flipped classroom worksheet helped them organize the main points in the flipped materials, while the in-class online worksheets helped them integrate the group discussion outcomes and draw complete conclusions. They also mentioned that the in-class worksheets, which were closely connected with educational contexts, enabled them to clarify and evaluate the main points from the discussion results.

Researcher: Did group discussion help you complete the online individual worksheets?
Participant (A2): The flipped classroom worksheets only included my own thinking, while the in-class online worksheets included opinions and suggestions from the group discussion, and thus the contents of the in-class online worksheets were the group members' integrated ideas.
Participant (B4): Yes. A lot of information could be connected as our own reference. The discussion results came from all the members' integrated ideas.

The double-presentation and the SOP^2 Model helped apply educational knowledge in the actual teaching and resulted in self-reflection (Resolution): The participants acquired new perspectives from many case studies and pedagogical practices shared in group presentations. Those students with actual teaching experience claimed that group demonstrations enabled them to reflect on previous teaching contexts, while those without teaching experience could catch a glimpse of authentic teaching environments. Additionally, many of the student teachers revealed that the group presentations not only broadened their horizons in terms of content knowledge, but also changed their original ideas about giving presentations. That is, they referred to other groups to adjust their own presentations.

Researcher: Did the group presentations help inspire you to learn new knowledge?
Participant (E1): Yes, one specific group was very creative and grabbed everyone's attention, making us think about how we could demo our presentations next time. We learned from other groups' presentations about how to present.
Participant (G1): Group presentations broadened my horizons, especially the practical cases in actual teaching jobs, so I got to take a look at what happens in the real teaching environment.

Quite a few students revealed that thanks to the SOP^2 Model, they could understand the educational issues thoroughly, and that the course design was helpful for connecting previous teaching experiences. Some students reflected on how to deal with problems if they were to experience similar educational contexts. This indicates that they were able to apply the learnt knowledge to the actual teaching. Furthermore, many students pointed out that the SOP^2 Model, especially the flipped materials, individual worksheet design, group presentations, and feedback sessions promoted logical thinking and self-reflection.

Researcher: Did the course design help connect with actual teaching jobs?
Participant (D1): I imagined what I would do if the same scenario occurred in my classroom. I also reflected on how I implemented the English teaching approach when I taught in the cram school and what the better solutions were.
Researcher: Would you try to apply what you have learned in your teaching jobs?
Participant (C2): Certainly. Because I learned not only theories but also many real cases which I could apply in the teaching contexts right away.
Researcher: Did the course design help facilitate self-reflection?
Participant (A2): Yes. I thought about the purpose of the worksheet questions and how to present the answers logically...and also how to present the tree map in the group presentations. Feedback from the teacher and peers also made me reflect on what I had learned and what should be improved after the course.
Participant (B3): I reflected on the teacher feedback and good presentations whose contents were new to me. I wondered why I had never thought of that before.

Conclusions

Our study, based on the Community of Inquiry (CoI) framework (Garrison, Anderson & Archer, 1999), developed a practical flipped classroom model (the SOP^2 Model), which was aimed to reinforce students' learning experiences through the interaction of cognitive presence, teaching presence, and social presence. Most previous CoI studies focused on online courses and CSCL contexts, but the present study further extended the realm to the flipped classroom context and demonstrated how the integrated SOP^2 Model in the flipped classroom could influence the student teachers' cognitive presence and learning achievements. Compared to previous CoI studies (Lambert & Fisher, 2013; Szeto, 2015), the present study extended the depth of analysis of cognitive presence (in all four dimensions: trigger event, exploration, integration, and resolution) in the flipped classroom context, with results showing that groups with a higher proportion of "Integration"(I) and "Resolution"(R) performed better on the post-worksheets and were also the most progressive groups. The major conclusions of the study are discussed as follows.

The impact of the SOP^2 model on learning achievements and cognitive presence

The paired-samples *t*-test results showed that the student teachers had much better performance on the post-worksheets. That is, it is indicated that improvements might have been made due to the flipped classroom integrating synchronous online discussion activities. Our instructional context increased learning effectiveness in terms of grades. As for cognitive presence, the student teachers had the largest proportion of category "E". During the "Exploration" phase students exchanged and shared divergent ideas, opinions, and experiences. The

second largest proportion was the "Integration" phase, in which the distribution rate of cognitive presence was rather high compared to previous studies (Kanuka et al., 2007; Meyer, 2003), implying that the participants were able to connect and integrate various ideas as well as form possible solutions for the discussed topics. However, the student teachers rarely reached the "Resolution" phase due to limited discussion time and a lack of teaching experience, which stopped expectations or opportunities for the application of the learnt knowledge. More time for discussions and for bringing more practical teaching cases into class might be beneficial for the reinforcement of students' cognitive presence.

Cognitive presence and learning achievements among groups

While the distribution of categories "T," "E" and "O" had no direct correlation with learning achievements, categories "I" and "R" correlated significantly with the post-worksheets and the score of discrepancy among groups. Results showed that the groups with a higher proportion of categories "I" and "R" had better performance on the post-worksheets. Additionally, the groups with a higher rate of the "R" phase were also the most progressive groups. Furthermore, the high-rated groups outperformed the low-rated groups in the "I" phase, with a higher frequency of organized solutions, and also in the "R" phase, with a higher possibility of offering solutions. Thus, higher cognitive levels including the "Integration" and "Resolution" phases were associated with better learning achievements in the collaborative online discussion environment (Akyol & Garrison, 2011; Garrison et al., 2001).

In terms of sequential behavioral patterns, both the high- and low-rated groups had significant sequences within their own dimension in the four cognitive categories and a significant correlation between the "Integration" and "Resolution" phases, which could be a critical factor in collaborative group discussion. It was also worth mentioning that there is only a slight difference between the high- and low-rated groups. The discussion patterns indicated that the high-rated groups listed out all the proposed resolutions in an integrated way at the end of the group discussion. Thus, the difference in directional correlation between the two phases resulted in disparity of high and low learning achievements. This finding indicates that while the low-rated groups gradually formed comprehensive resolutions from the integration phase, the high-rated groups paid more attention to integrating the concrete resolutions once they were raised.

Perceptions of the SOP^2 model for cognitive presence

The participants believed that the self-studying flipped materials motivated learning interest and problem-solving in educational contexts (Triggering event), while the online group discussion helped them explore knowledge and exchange diverse information (Exploration). Furthermore, the online discussion activities and worksheet designs helped integrate proposed solutions and construct knowledge related to educational contexts (Integration). Moreover, the two-stage presentations changed the students' original mindset regarding giving group presentations. Lastly, the SOP^2 Model helped associate the knowledge with the actual teaching environment and helped the students engage in personal reflection (Resolution).

Pedagogical implications

Offering practical pedagogy and educational knowledge to prospective teachers

The importance of incorporating information technologies into education has been an important topic since the beginning of in the 21st century, and higher-order thinking skills have since been considered essential abilities (Salpeter, 2003). Our instructional approach enables the student teachers to experience technology-supported and higher-order learning activities as well as the global trends of ICT contexts, including autonomous learning, collaborative learning, and individualized instruction (Sergis, Zervas, & Sampson, 2014). Incorporated into ateacher education program, our instructional designs aim to offer a realistic pedagogy and relevant educational knowledge to student teachers so they can be prepared for the implement of a similar instructional approach in their own future classrooms.

Recommendations for instructional designs in flipped classrooms

Currently, empirical research offers no recommendations regarding what technology tools or design features can best support flipped classrooms (Peña & Rosson, 2014). Based on our study results, however, it is indicated that

the student teachers' learning achievements could be greatly improved when integrating online synchronous group discussion in flipped classrooms. In addition, the integration of the SOP^2 Model enabled the participants to reach the "Integration" phase, which is a higher level of cognitive presence (Garrison et al., 2001), constituting the second largest proportion in our study. Thus, the SOP^2 Model, incorporating our instructional designs and procedures, might be able to provide recommendations for future implementations of flipped classrooms in a higher education context.

Promoting integration and resolution phases for the cognitive presence

Our study results indicate that the groups with a higher proportion of "Integration" and "Resolution" phases had better learning achievements and progression in terms of their worksheet scores. In addition, both the high- and low-achievement groups had significant correlations between the "Integration" and "Resolution" phases. Thus, it is suggested that more emphasis should be put on facilitating the "Integration" and "Resolution" stages, which are critical factors for increasing participants' learning achievements. We also discovered that sequential discourse from "Resolution" to "Integration" led to better learning performance than "Integration" to "Resolution." Thus, to foster "Integration" and "Resolution" phases, several adjustments could be made based on learning activities and instructional design.

Since previous studies have suggested that role assignment could facilitate higher-level cognitive presence and knowledge construction, it is recommended that each group distribute roles, such as group leader, information provider, resolution organizer, and discussion moderator, before online discussion. Meanwhile, instructors could encourage students to conduct small group communication by providing discussion resources such as links, printed flipped materials, PDF files, and personal comments or reflections for each educational context prior to in-class sessions. Participants could then briefly review and become familiar with the prepared materials in order to offer related ideas and thus conduct efficient group discussions. Also, instructors could demonstrate discussion techniques regarding how to reach the "Integration" and "Resolution" phases. For example, each group can re-organize or summarize developed resolutions at the end of their online discussion. In addition, specific cases relevant to the discussed contexts could be offered to show students how to integrate and apply their proposed ideas and resolutions. Lastly, in terms of instructional design, future flipped courses could prolong the duration of synchronous online discussions by offering more time for each discussed context or by reducing the number of discussed questions so it might be more possible for participants to reach the "Integration" and "Resolution" phases.

Limitations

The sample size was small, involving a class of 31 student teachers whose learning outcomes might not be generalized to other participants or groups. Since there was no random assignment in this study, the results might be restricted to similar instructional contexts. Even though discourse analysis and evaluation of worksheets might cause subjective bias based on actual situations, we have limited such possibility by having two researchers conduct analysis in order to increase consistency. Although there was no control group, the purpose of the present study was to develop a practical flipped classroom model and thus the focus was on the instructional procedures. In addition, three cycles of the SOP^2 model were fully conducted throughout the semester, and possible effectiveness was evaluated based on significant improvement in the achievement scores ofthree different individual worksheets.

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