Developing an epistemic community in the classroom as teacher professional development

Xueli Wang, Beaumie Kim, Jason Lee and Mi Song Kim
National Institute of Education, Singapore

Abstract: This study attempts to understand the influence of developing epistemic community in classroom on teacher's professional development. The case study reveals that implementation of an epistemic community approach in classroom not only benefits students' learning, but also has a significant effect on teacher's own professional growth. We also found that the teacher developed her professional knowledge and skills in terms of facilitating students' ideas, generating and applying new strategies. We illustrate the process of individual teacher's professional growth through developing epistemic community in classroom. Evidences from this study suggest that 1) teachers' professional development could take place more meaningfully in regular school day; and 2) developing epistemic community in classroom provides a meaningful vehicle for teacher to participate in their own professional growth while enhancing students' learning. The current study may provide new insights into how individual teachers could develop their expertise together with students in classroom situations.

1 Introduction

Professional development for teachers is generally acknowledged to be an important component of improving teacher practice and students' learning. Researchers' work on professional development ranges from identifying conditions of learning, to elaborating the process of how professional knowledge develops, to designing effective professional development program (Garet, Porter, Desimone, Birman, & Kwang, 2001). Particularly, a number of studies indicate that teacher change is perceived as positive results of teachers' involvements in professional development programs, and professional learning communities and activities (Clarke & Hollingsworth, 2002; Richardson, 1998). Questions emerged in the previous studies on teacher change include whether changes in knowledge, belief and attitudes precede or follow changes in teacher practice (Fullan, 1982; Guskey, 1986). Some studies suggest that teacher's practice will improve and students outcome will increase when teachers gain their knowledge and change their belief and attitudes on effective instructional method (Clarke & Hollingsworth, 2002; Guskey, 1986, 2002). This kind of ideas, however, may represent teachers' change as a linear process and fail to consider the multiple pathways in the process of teacher change and the characteristic of life-long learning in professional growth. Given these shortcomings, Clarke and Hollingsworth (2002) turn the linear structure of model into interconnected, non-linear structure of model in order to explain the interrelationships among four domains-personal domain, external domain, consequence domain and practice domain. Clarke and Hollingsworth (2002) emphasize that teacher's change in one domain is associated with change in another. This interconnected model provides a framework to understand the underlying meaning of teacher's change and to design professional development strategy.

Recently, some studies (e.g., Clarke & Hollingsworth, 2002; Dana, Gimbert, & Silva, 2001; Garet, et al., 2001) have documented the shortcomings of formal professional development training in the way of short term workshops, professional courses and so on. These formal professional development programs usually take place outside of school and classroom, which might be difficult to be transferred into the classroom practices. Hence, there are growing interests in new types of professional development, which take place in teacher's regular workday through observation, reflection, and the exchange of professional ideas focusing more on making connection between different approaches and classroom practice (e.g., Baumfield, 2006; Dana, et al., 2001; Zwart, Wubbels, Bergen, & Bolhuis, 2007). Similar to their perspectives, we also found that a teacher involved in our school implementation is shaping her professional growth as an active learner through co-design work with researchers and classroom practice. More specifically, the teacher has expanded her professional knowledge and skills by developing epistemic community together with students in classroom.

Epistemic community describes a transition from teacher dominated learning to students monitoring their own learning. It is based on one of the twelve principles proposed by Scardamalia (2002) for epistemic agency which focuses on changing students' activities and students' roles in learning. She illustrates the socio-cognitive dynamic involved in epistemic agency as*: "Participants set forth their ideas and negotiate a fit between personal*

Wang, X., Kim, B., Lee, J.W.Y. & Kim, M.S. (2011). Developing an epistemic community in the classroom as teacher development. In S. Barton et al. (Eds.), *Proceedings of Global Learn Asia Pacific 2011* (pp. 1272-1281). AACE.

ideas and ideas of others, using contrasts to spark and sustain knowledge advancement rather than depending on others to chart that course for them. They deal with problems of goals; motivation, evaluation, and long-range planning that are normally left to teachers or managers (p.78)". Under this context, students take responsibility for their own thinking and problem solving. They manage their own learning and monitor the proceeding of their collaborative effort, rather than waiting and receiving 'authoritative answers' from teacher. However, such transition to the epistemic community may not happen only by teachers' attending workshops outside of classrooms. What's interesting is that the challenges of new teaching approach related to the conceptions teachers have of their roles in the classroom. More specifically, this breaks with the traditional way of organizing classroom activities, which change the teacher's professional role and practice in classroom.

We attempt to understand the influences of developing epistemic community in classroom on teacher's professional development. We want to keep an open mind to the non-linear aspects of the professional growth that occurred when a teacher develops and takes part in an epistemic community. We argue that 1) teachers' professional development could take place more meaningfully in regular school day; and 2) developing epistemic community in classroom provides a meaningful vehicle for teacher to participate in their own professional growth while enhancing students' learning. This may provide insights into how individual teachers could develop their expertise together with students in classroom situations.

2 Professional development models

In this paper, we will concentrate our discussion on one teacher's change in classroom, which affects and is influenced by students' changes. Data were gathered using various methods which include observation of her teaching practice and interactions with her students in classroom through video recordings. In addition to that, the teacher's blogs were analyzed in order to explore any change on her attitude and beliefs about teaching and learning. Students' reflections were also analyzed as indicators of teacher's practice and the effect on students' learning.

We adopted the interconnected, non-linear structure of models, elaborated by Clarke and Hollingsworth (2002), because: 1) the model allows us to identify multiple patterns of learning in the process of professional growth; and 2) the model has been used as a tool for classifying the data of teacher change successfully. According to the models, the teachers' professional world could be seen through four distinct domains and the multiple pathways among the four domains which reflect the complexity of teacher's professional development. The authors defined the four domains briefly, which are *'the personal domain (knowledge, belief and attitudes), the domain of practice (professional experimentation), the domain of consequence (salient outcomes) and the external domain (source of information, stimulus or support)'* (Clarke & Hollingsworth, 2002, p. 950).

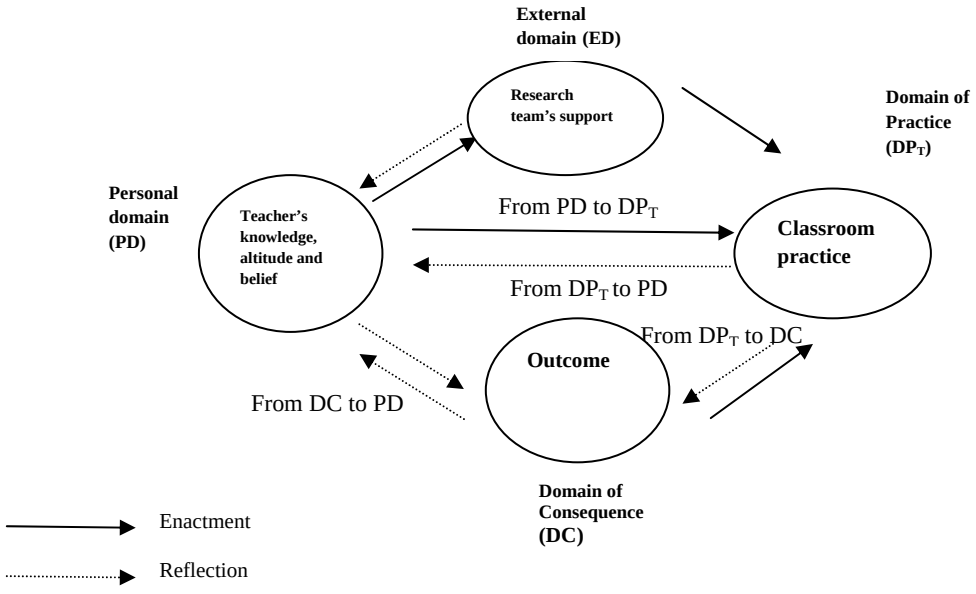

Figure 1. The interconnected model of professional growth, adopted from Clarke & Hollingsworth (2002, p. 951)

In order to facilitate data coding, the four domains are redefined in the context of our project: personal domain (PD) defined as teacher's knowledge, attitude and belief; the domain of practice (DP_T) as classroom practice; external domain (ED) as the supports from research team; and the domain of consequence (DC) as the indicators of students' understanding. We use four criteria to understand the relationship among these domains: 1) From PD to DP_T: The process from personal domain to domain of practice occurs when a specific aspect of teacher's cognition influences her practice in classroom or teacher implements new strategies emerged from her reflections; 2) From DP_T to PD: The process from domain of practice to personal domain happens when teacher reflects on her professional practice or generates new strategy; 3) From DP_T to DC: the process from domain of practice to domain of consequence happens when a specific aspect of teacher's implementation influences students' performance and outcome; and 4) From DC to PD: the process from domain of consequence to personal domain occurs when teacher reflects on her classroom practice or implementation of new strategy based on students' responses. As only the four interactions emerged in our data, some interactions (e.g., changing from the personal domain to the domain of consequence, from the personal domain to the external domain) summarized in Figure 1 have not been discussed in this study.

In the following the Clarke and Hollingsworth (2002)'s models as basic framework for establishing the relationship among the various data sources, we discuss the process of individual teachers' professional growth.

3 Professional growth in the classroom

The data for this paper comes from a larger research program 'Voyage to the Age of Dinosaurs' (VAD) (Kim, Miao, Chavez, Kim, & Shen, 2007-2010; Kim, Wang, Tan, Kim, & Pang, 2009). The main objective of the research project was to explore ways to develop an interactive media that supports students' deep learning about Earth system science. To incorporate the game with classroom activity, we designed the game to be integrated in the curriculum and conducted school implementation in Singaporean secondary schools. The curriculum was designed based on our principles of learning design including: 1) engage them in group activities (developing epistemic communities); 2) starting with open-ended questions (setting up the meaningfulness of the topic); 3) engage them in activities that provide relevant experience (using game or other tools); 4) require them to produce group or individual artifacts (encouraging their ownership of the process and product); 5) develop a sharing mechanism of the class (encouraging making their ideas public and further conversations); and 6) engage them in consolidation and linking activities (understanding the connections and gaining confirmation about their ideas) (Kim, 2010).

The school implementation was from January to May 2010 with a class of Secondary One students (US grade 7 equivalent) and a geography teacher. The teacher, Nicole, is an experienced teacher who has taught in secondary school about 8 years and tried game based learning in her previous school before joining the secondary school this year. Based on her blogs, she perceives this project as using an inquiry-based learning (IBL) approach which she learnt about before participating in the current project. Students participated in our research did not know each other as this is the first semester in their secondary school life. During the implementation, we recorded every classroom activities using voice recorders and camcorders (two or three times weekly). After each lesson, we had an informal meeting with the teacher to discuss the lesson and future lesson plan. Our discussions were focused on open-ended questions or thinking questions (Nicole called them so in the class) and activities which were designed to engage students in meaning making and experiential learning activities.

The professional growth of the teacher is often made by the changes of environment (e.g., quality of students, school culture and teacher's experience and personality). In this study, we focus on the impact of four domains (teacher's personal domain, external domain, consequence domain and professional practice domain) on teacher change in our school implementation. Based on our data collected, one interesting aspect we found in Nicole's reflections and classroom practice is the change in how she perceives her role in classroom. The significant points of personal domain are revealed in the process of professional growth as she sees herself becoming the facilitator and learner.

Based on our observations, we found that Nicole's role began as a teacher who is good at managing the class in terms of directing instruction, getting students' attentions, asking good questions and effectively presenting knowledge. During the first week's school implementation, she followed the lesson plans that were prepared mostly by the research team after the discussions with participating teachers. The role of the research team at the beginning was being the 'expert' who drives the design of the thinking questions and classroom activities in detail. We also observed during the initial stages of the lessons, only a few students interacted with Nicole and express their ideas

aloud in the classroom. After the first week, Nicole changed her practice in order to meet challenges emerging from classroom practice. During this time, she came up with the strategies that help developing the epistemic community. In the next section, we will illustrate the process in details.

3.1 Developing strategies for creating an epistemic community

To help develop the epistemic community, the research team suggested Nicole to use students' ideas and artifacts to make the knowledge their own and use students' experiences as resources for their learning. Meanwhile, the research team discussed with Nicole together to make the thinking questions better connected with the topics of her class. After the discussion with the research team, Nicole attempted to change her practice when she began to understand that students indeed have rich prior knowledge. Facing the unpredictable questions and ideas generated by students, she decided to pay more attention to explore what students already know. As she stated in her blog,

> *I learned that students were giving all sorts of answers through my questions. And perhaps one comment can just lead to the next and so on…Pupils really do come with a rich schema of knowledge. I am glad that I made a conscious effort to find out what they already know.* (January 19, 2010)

To elicit students' prior knowledge, Nicole integrated the IBL approach she learnt previously to her current teaching plan as she saw the connection between what she is doing and the IBL approach. Additionally, she increased the flexibility to her teaching plan in order to spend more time on building on students' answers. To develop epistemic community in which students are engaged and motivated in an opened but manageable environment, three strategies emerged in Nicole's professional practice during four-month school implementation. At this stage, she perceives herself as a facilitator which motivates her to meet the challenges emerging from her classroom.

In the following, we describe in detail what might indicate Nicole's transition to playing more of a facilitator role in class from both our observations in her practice and Nicole's blog entries.

3.1.1 Strategy #1: Encouraging students to use their prior knowledge

In this class, group activities are mainly formed in classroom interaction in which students are asked to discuss and solve problem. The question emerged in Nicole's class practices was how much time is appropriate to allocate for students to think about the questions and generate their responses for discussion in class. Using the model described in Figure 1, we describe how Nicole reflected and modified her practices in dealing with the situation. Below is the model of developing the strategy (see Figure 2).

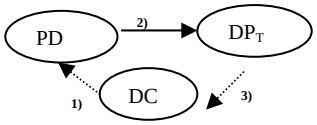

Figure 2. The development of strategy #1

1) From Domain of Consequence to Personal domain (DC to PD)

Initially, Nicole felt disappointed from the students' responses when students were unable to answer to her questions on the earth's season in class. She pointed out that students were not thinking critically when she commented that 'everybody is talking about tilt, but not about why it relates to the seasons' (DC). By reflecting on students' performance, she generated the strategy that give students more group discussion time to encourage students to discuss and think deeply (from DC to PD). Nicole wrote her reflection in her blog,

> *I am quite disappointed with their presentation today (season). Is it because their knowledge of the earth's day and night plus the season is minimal; therefore they are only able to present at such a standard? Or is it because they do not have sufficient time (15mins) to work together as a group?* (January 19, 2010)

2) From Personal domain to Domain of Practice (PD to DP$_T$)

In Nicole's following classroom practices, the new strategy of extending the group discussion time and inviting students to share their ideas with their classmate has been implemented (from PD to DP$_T$). Subsequently, equality of opportunity among students involved putting forward their ideas appears to be her greatest concern.

Particularly, she pays more attention to the quiet students and encourages them to express their ideas (DP_T).She summarized her practice of the strategy in her final reflection after class implementation, she stated,

> *I give them group discussion time so that they gain confidence in their thought process and then I invite them from the respective groups to share by calling on the quiet ones.* (April 24, 2010)

3) From Domain of Practice to Domain of Consequence (DP_T to DC)

With Nicole implementing the strategy in her classroom, the influences of the new strategy on students' behavior are identified. It shows that students start to contribute to classroom discussion (from DP_T to DC). More specifically, it encourages students, especially quiet students, to think through their answers and speak out (DC). The evidences can be found in one of the quiet student's reflection:

> *I am quite shy and I rarely speak, unless the teacher forces me to do so. But as the lesson progressed, I was encouraged by my warm classmate and Miss Toh (Nicole), I improved myself confidence and I spoke more.* (Garnett)

Giving the chance for students to work with their ideas helps them feel the importance of their voice. It is important for students to have the opportunity to bring up and share their ideas and discuss together in the community, which is a basis of engaging students to contribute to the knowledge advancement in the classroom (Scardamalia, 2002). This strategy creates the environments of sharing ideas in classroom, which provides the basic elements for developing epistemic community in the classroom.

3.1.2 Strategy # 2: Helping students question themselves

By engaging in thinking activities, students not only think about the questions given by the teacher, but also raise their own questions about the concepts. To encourage the students to be active learners in the classroom, Nicole employed a strategy that uses the student's questions as thinking questions which empowers the students to think and find out at home. The questions will then be discussed in the subsequent class where the students are encouraged to share their answers with their fellow classmates. Below is the excerpt in which Nicole describes how she is changing her role as facilitator

> *I don't have the answers to these questions in class. I was very conscious this time round that I should not be attempting to answer any of the flurries of questions raised. What I was consciously doing as facilitator of learning was to ask the questions back at them and to encourage them to ask more questions. Along the way, I praised them for their great questions and asked them to record the questions raised in class in their geography journal that we can come back to it.* (February10, 2010)

Subsequently, Nicole found that the strategy of employing students' questions as thinking questions has a multiplying effect on developing students' learning. We found that this creates an interesting debate in classroom which 1) motivate students to complete thinking questions at home; 2) engage students in classroom activities; and 3) encourage them to think and develop ideas together. Using the professional growth development model described in Figure 1, we describe how Nicole develops this strategy. Figure 3 is the model of getting students to question themselves.

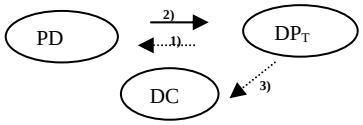

Figure 3. The development of strategy #2

1) From Domain of Practice to Personal Domain (DP_T to PD)

When teaching the topic of Earth phenomena, students raised a question 'if the size of eruption is dependent on the size of the volcano'. Rather than giving the answer directly, Nicole asked students to find out the answers by themselves. In the next lesson, Nicole was surprised that most of the students have done their homework (DP_T). Interestingly, Nicole noted that the students started a lively debate which enhances their views as the discussion brought up many other factors that could cause the earth phenomena. Nicole summarized the practice in her blog the following,

> *Bryan raised an interesting question in class. He wanted to know if the size of eruption of dependent on the size of the volcano. Instead of giving them the answer, I asked the class to find out and generally, more of them did. This led to a lively debate in enhancing views where the boys brought up various*

other factors that might indeed affect the volcanic eruption instead of the size of volcano. (March 31, 2010)

When Nicole realized that students were more actively engaged in the class discussion, she develop the strategy of thinking questions to enhance students' learning and engagement and to make students take responsibility of their own learning (from DP_T to PD). More specifically, Nicole decided to employ the questions generated by students in classroom instead of using the thinking questions from the research team (PD). Nicole noted in her blog the following,

> *I realized that geography thinking questions can only be completed if the pupils are motivated enough to find out the answers. Perhaps if the questions had come from them, instead of from me, the pupils will be more motivated to find out the answers.* (March 31, 2010)

2) From Personal Domain to Domain of Practice (PD to DP_T)

From subsequent classroom observations, we found that Nicole developed and implemented the strategy of employing students' questions as thinking questions to her class (from PD to DP_T). For example, in a classroom observation on the topic of air pressure, Nicole gave the students opportunities to share their ideas and to clear up any queries they had. In this lesson, the students generated two questions which were: 1) 'Why does air become less dense at higher altitudes?' (See turn #2 and turn #4); and 2) 'Why doesn't the temperature rise as we are on a higher altitude seeing that we are closer to the sun and that hot air rises to the top?' (See turn #5 to turn #8). Rather than responding to the questions immediately, Nicole left the questions to students as their own thinking questions and asked students to resolve by themselves (See turn #6).

1. *Nicole: …We've got two interesting questions that have sprouted out. I wonder if some of you may have the same questions. Now, when the air molecules are ( ) apart, the lower you go, the molecules are denser. Air is denser as altitude increases. Why is it denser? And what he's trying to say is that air molecules become closer. ….*
2. *Jerry: when lower density air heats up, doesn't it rise? Become less dense?*
3. *Nicole: Let's get this straight, ok? Let's define our thinking question and tomorrow I want you to come back with it, ok? Alright. Let us define our thinking question. So what do you want to research on that? Yes, Bryan?*
4. *Bryan: Why does air become less dense at higher altitude?((Nicole repeats and writes the question on the board))*
5. *Bryan: How come the base of the mountain is hotter than the atmosphere? When hot air rises?*
6. *Nicole: Would you like to resolve this on your own? It's a thinking question…Why does air become less dense at higher altitude? Yes, Jimmy?*
7. *Jimmy: Because it's on a higher ground right, won't it be a burden to the sun and it will rise up?*
8. *Students: No, the sun is so far away* (April 13, 2010)

3) From Domain of Practice to Domain of Consequence (DP_T to DC)

With the implementation of the strategy, more students started to contribute to classroom discussion and developed their critical thinking skill (from DP_T to DC). Students wrote down in their reflections following,

- *We came up with many interesting questions, example, in the learning of IDL (International Date Line), someone asked 'who decide IDL?' and that became our thinking question and we discussed the question next lesson. It's different from other lesson… lesson in this geography class is much more interesting than other lesson.* (Cheng)
- *The thinking questions given were very enriching and mind stimulating. From the quiet me who does not contribute much in class to bubbly me that speaks more now, that is very big development.* (Perry)

According to the findings, it shows that the epistemic community is developing in the classroom as this strategy helped students engage in interactive questioning and classroom discussion to build on each others' ideas.

3.1.3 Strategy # 3: Increasing students' ownership of knowledge

This strategy comes along with the strategy of '*helping students question themselves*' to develop the epistemic community in class. To encourage students to share their ideas and build answers by their own discussion, Nicole 1) facilitates students' ideas by asking more questions; 2) allows students to debate on new concepts by clarifying their opinions; and 3) synthesizes students into the direction that she would like the lesson flow. In this

way, students could not only make connection to their own prior knowledge, but also arrive at an understanding. Using the professional growth development model described in Figure 1, we describe how Nicole develops this strategy. Figure 4 shows the model of developing the strategy of increasing students' ownership of the knowledge.

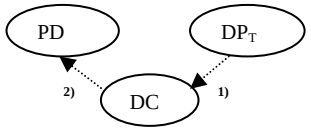

Figure 4. The development of strategy #3

1) From Doman of Practice to Domain of consequence (DP_T to DC)

Below are excerpts from classroom practices in which Nicole applied co-construction of knowledge into her classroom practices. In this class, Nicole encouraged students to contribute to discussion and debate on the question 'why does denser air retains heat better than less dense air?' (see turn #9, turn #11 and turn #13). When the class discussion appeared to be stalled and not making much progress, a student used a metaphor of clothing to help class understand and clear up students' confusion (see turn #16).

9. *Nicole:… as I was saying I hope you've reached a comfortable level that where you are able to question your friend (and) your classmate whereby you don't understand a certain part you like to elaborate you like you add on or you like to say: I think what he's trying to say is this. Let's have a contribution, shall we? Ok, we have a sharing session now. If you'll like to start the ball rolling. And Henry looks like he's ready. He's just needs a little bit of encouragement is it? Ok, Gin starts.*
10. *Gin: I'll start with the second question …From my research they say ….because it…..*
11. *Nicole: Do you think he answers the question that you guys have researched on? So you're saying the air is less dense here? ....So you were showing that the air molecules are further apart and this part was like the air molecules are closer together so Kevin you were saying something?*
12. *Kevin: ...Because Gin he explained …...So he said that we won't know why the reason of why the air at higher ground is less dense than air at lower ground…*
13. *Nicole: So do you know the reason why air is less dense at higher ground and denser at lower ground? Would you like to share?*
14. *Kevin: There is a type of force in earth called gravity. Gravity pulls air down and it causes lower part to be denser and the higher part to be less dense. Bryan, were you saying something?*
15. *Tony: But some people say the sun will heat up the air …Gin said that the air nearer to the sun will be heated up by the but then Kevin said that Gin said that it will expand but Kevin said that there are no difference. Then which one is correct… I'm just saying that Gin said that the air molecules will expand but why Kevin said that they will be more dense.*
16. *Bryan: Gin said because at the surface he said it expands but actually it doesn't. If we are wearing like tight clothing at cold area it's actually warmer than wearing lose clothing in a warm area. So it's like the air molecules is like the sweater if it is tightly bounded together it traps more heat but then if it's like the lose clothing then its more spread apart. If it's more spread apart heat is a lot heat passes through it so it isn't all retained together. ((Class cheers and claps))* (April 14, 2010)

With the implementation of the new method, students feel more encouraged to share their ideas and monitor their own learning (from DP_T to DC). Students noted in their reflection:

- *The method we learn is much more different...However, in this environment, we learn quite independently .Using our basic knowledge, we discuss and compile all our knowledge together to learn about geography.* (Jin)
- *I think geography lesson is special, because in other lesson we hardly get to share our thoughts.* (Albert)

2) From Domain of consequence to Personal domain (DC to PD)

By reflecting on students' performance, Nicole realized that respecting students' ideas helps establish the safe environment where students can share their ideas and preconceptions with classmates and teachers freely (from DC to PD). She summarized the influence of the ideas in her final reflection,

> *Respect is a huge culture in the classroom- the teacher respects and values the pupils' ideas, response and opinions. Likewise, the pupils show it to their peers…Respect brings about a Safe environment.* (April 24, 2010)

Additionally, she found that this strategy could help students manage their own learning and make connection between their prior knowledge with the current learning. Nicole noted this in her reflections,

> *In fact in doing so, the child also demonstrates ownership in his own learning!* (April 24, 2010)

Evidently in this classroom something has happened when the teacher played the facilitator's role who engages students in discussion, sharing ideas and debate on geography knowledge. She describes the meaningful learning as taking place when students interacting with others, testing other's ideas and making connection with their preconceptions.

With the change in Nicole's professional practice, students were encouraged to probe the underlying reason of the answers to make judgment and justify their ideas in which they develop their critical thinking. In addition, students gain confidences when they obtain respects from teacher and their classmates. Below are the excerpts from students' reflection in which they mentioned they have more opportunities to express their own ideas and to build ideas together in this class and gained confidences from that,

- *The things I like about geography lesson are the thinking questions. They enable us to learn things that one beyond our text book.… (We) discuss them on our own and come up with a final answer to present to the class. It also allows us to bond better. During lessons, everyone gets a chance to speak too. (Richard)*
- *I feel that through geography lesson, I have developed into person with more self–esteem and confidence as I can converse more freely in class (Timothy)*

In another example, one of the quiet students stated this lesson not only enhance his knowledge in geography, but also improve his attitudes in learning. Below is the excerpt from his reflection,

- *I think this lesson is good because I had improved my attitude, character and skills besides learning in geography (Vincent)*

Based on Scardamalia (2002)'s definition of epistemic community, it's reasonable to conclude that the epistemic community has been created in this classroom as students took responsibility for their own thinking and problem solving and coming to a deeper understanding through interactive questioning and classroom discussion.

3.2 Becoming part of the epistemic community

Towards the end of the semester, Nicole became a better facilitator in the classroom. Meanwhile, she realized that she is becoming a learner who is part of the epistemic community. It makes her develop greater empathy with her students (McGregor & Gunter, 2001). More specifically, it helps Nicole understand the ways students thinking and their learning difficulties. Also, it motivates Nicole to enhance her professional knowledge and to learn new strategies and approach.

At the end of semester, Nicole started to ask questions to herself as a learner when preparing lessons for students. She realized that she started to learn the geography related content beyond the text book to deal with the unpredictable questions generated by students and the question brought up by herself which made her transform to be a better teacher. Nicole wrote in her blog,

> *In fact, it starts with many students asking me questions which I don't usually face in class. and along side I am also asking myself questions as I am preparing my lessons and even thinking out loud as I am teaching in class. It is scary because the answers are not always apparent and it takes effort to find out. What I was just sharing with Lara and Jason (members of the research team) today was that it makes me a better teacher and most importantly a better student. I never raised so many of these questions when I was a geography student. I was just like a passive recipient of geography facts. 'This is how it works, so just accept it. I never quite question things like the reasons behind how things work even the most basic of concepts. And now, I am forced to know coz my students are questioning me and even I am questioning myself too. It's like I have never known so much about what I don't know as Geography teacher teaching the same stuff that I have been teaching over the years*. (April 6, 2010)

In her final reflection, she also indicates that the role of learner could help her become a good facilitator of learning and better understand students' learning difficulties. Below are excerpts,

> *IBL (Inquiry based learning) requires the teacher to be open to learning and to learn together with class. It transforms her role into one that is really a facilitator of learning…The ability to better understand my pupils' difficulty in learning certain concepts through IBL* (April 24, 2010)

According to our observation, almost about 80% students contribute to class discussion at the end of semester (some through their small group discussions) and they are mostly engaged in thinking about the same issue (i.e., not chatting off-topic). Particularly, quiet students raise questions and share the ideas actively. Students become participants in the learning community by having more equal and responsible roles.

4 Discussion

According to our findings, we noted the changes of Nicole's perception of teacher's role interact with the changes of other domains which reinforce the Clarke and Hollingsworth (2002)'s interconnected models. In sum, we find that Nicole and her students have improved their own knowledge and skills simultaneously throughout developing and participating in epistemic community in this study. More specifically, Nicole has changed her role in classroom which increases students' motivation in learning. Particularly, we found that the students' role has changed from being a passive participant to being an active learner and contributor to the classroom. The teacher and the students were working together to co-construct knowledge that were at times beyond the syllabus. The role of the research team also has changed from being the domain expert to being a collaborator with the teacher.

4.1 Teacher's change through the epistemic community development

This case study provides an insight into how a teacher has changed her perspective and professional practice by developing epistemic community in class. We argue that developing and participating in an epistemic community in classroom is synonymous with professional growth and provides development, which can potentially lead to meaningful changes for the teacher and students. The epistemic community approach is one of the ways to encourage students to take responsibility of their own learning and provides students with more opportunities to present their preconceptions and bring forward questions. It challenges the traditional role of teachers and the way of teaching in classroom. By meeting the challenges and participating in the community, the teacher can make his or her own professional growth. More specifically, the case study shows that the unpredictable preconceptions and questions raised by students can successfully trigger 1) teacher's interests to change her role in classroom; and 2) the commitment to improve her professional skill by exploring her potential skill. Additionally, the powerful and dynamic stimulus in epistemic community can encourage the teacher to 1) probe further ideas of students; 2) bring forward and modify strategies based on her classroom practices; and 3) enlighten her perception of making of her classroom practices.

Most importantly, the teacher involved in our study applied these strategies, which emerged from her own reflection on and connection between the research team's suggestions and what she has learnt previously (i.e., IBL). This differs from traditional professional developments which focus on the knowledge being sharing with group of teachers. More specifically, the traditional professional development may help teachers enhance their knowledge but may not lead to meaningful changes in the classroom (Garet, et al., 2001). As highlighted in previous studies, the relationship between a new strategy and the classroom practice has the important role in the teachers professional growth (Kaasila & Lauriala, 2010). In particular, a teacher's professional growth should not only occur in their knowledge and belief, but also in the practice. A teacher should be able to apply the strategies they learnt during professional development program or university into the classroom practice and keep the mind to improve her/his professional skills and knowledge during the regular school days. Therefore, in this case study, the epistemic community approach was an effective way to improve teacher's professional knowledge and skills by learning and practicing simultaneously.

4.2 Research team's role from the teacher's perspective

In this case study, with the changes of Nicole's role in the classroom, the relationship between research team and teacher is influenced by the teacher's role in learning in the process of developing an epistemic community. At the beginning of the semester, the research team helped creating the environment and framework for developing epistemic community. The team suggested the ideas of classroom arrangement, thinking questions and group

activities in lesson plans before the school implementation, and then observed and provided feedback on the classroom activities. The research team then was perceived as an evaluator by Nicole. Below is the excerpt from Nicole's blog in which she mentioned she assessed her lessons depending on research team's feedback.

> *I know the lesson was probably not too good if 1)…2) Beaumie (leader of the research team) starts asking, 'so how do you think the lesson went?'* (Feb 10, 2010)

Being a facilitator, Nicole perceived the research team as peer who discusses the lesson and share ideas and suggestions with her. Below is the quotes from her blogs in April in which she discusses the learning problem emerged in classroom with research team and get hindsight from research team's feedback,

> *On the hind sight, after what Beaumie and Lara (researcher) pointed out the next day, it's true that it just goes to show the students limited knowledge of the structure of the earth, like the thickness of the crust, the depth of magma, the heat level and so on.* (April 2, 2010)

Being a facilitator and learner, Nicole transforms her perspective of the research team from her peer towards learner who learns with her and students together in the epistemic community.

> *Why is it that when the alcohol contracts in the daily minimum thermometer…?' I wonder aloud in my thinking as I was teaching the pupils on how the thermometer works. I shot my foot as I could not find the answer even with Lara's help.* (April 6, 2010)

The research team also participates in the epistemic community in that the team not only provides ideas and suggestions to class implementation, but also learns geography knowledge with the teacher and students.

In sum, the role of the research team and relationship between the teacher and the research team are changing along with the development of teacher and epistemic community in classroom.

5 Conclusions

This study suggests that developing epistemic community in classroom not only benefits students' learning, but also has a significant effect on teacher's changes. It offers a fruitful means of stimulating and supporting teachers' professional development by challenging the relationship between teacher and students in learning activities. Our experience led to a description of developing epistemic communities as a powerful strategy to influence change on teaching and learning. More specifically, students and teacher in the community elicit both his/her own as well as other's potential contributions to learning.

References

Baumfield, V. (2006). Tools for pedagogical Inquiry: The impact of teaching thinking skills on teachers. *Oxford Review of Education, 32*(2), 185-196.

Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education, 18*, 947-967.

Dana, N., Gimbert, B., & Silva, D. (2001). Teacher inquiry as professional development for the 21st century in the United States. *Change: Transformations in Education, 4*(2), 51-59.

Fullan, M. (1982). *The meaning of educational change*. New York: Teachers College Press.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Kwang, S. Y. (2001). What makes professional development effective? Results from a National Sample of Teachers. *American Educational Research Journal, 38*(4), 915-945.

Guskey, T. R. (1986). Staff development adn the process of teacher change. *Educational Researcher 15*(5), 5-12.

Guskey, T. R. (2002). Professional development and teacher change. *Teachers and Teaching: Theory and practice, 8*(3/4), 381-391.

Kaasila, R., & Lauriala, A. (2010). Towards a collaborative, interactionist model of teacher change. [doi: DOI: 10.1016/j.tate.2009.10.023]. *Teaching and Teacher Education, 26*(4), 854-862.

Kim, B. (2010). *Note on game-integrated curriculum* (Proposal). Singapore: National Institute of Education

Kim, B., Miao, C. Y., Chavez, M., Kim, M. S., & Shen, Z. (2007-2010). Serious immersion and embodied learning: Traces of dinosaurs in earth system science (Grant No. NRF2007-IDM003-MOE-002). Singapore: National Research Foundation.

Kim, B., Wang, X., Tan, L., Kim, M., Lee, J., & Pang, A. (2009). *Designing with stakeholders for learning innovations: Voyage to the Age of Dinosaurs*. Paper presented at the Annual Meeting of American Educational Research Association.

Wang, X., Kim, B., Lee, J.W.Y. & Kim, M.S. (2011). Developing an epistemic community in the classroom as teacher development. In S. Barton et al. (Eds.), *Proceedings of Global Learn Asia Pacific 2011* (pp. 1272-1281). AACE.

McGregor, D., & Gunter, B. (2001). Changing pedagogy of secondary science teachers: the impact of a two-year professional development programme. *Teacher Development*, *5*(1), 59-74(16).

Richardson, V. (1998). How teachers change: What will lead to change that most benefits students learning? . *Focus on basics: Connecting research and practice*, *2*(c). Retrieved from http://www.ncsall.net/index.php?id=395

Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of knowledge. In B. Smith (Ed.), *Liberal education in a knowledge society* (pp. 76-98). Chicago: Open Cour.

Zwart, R. C., Wubbels, T., Bergen, T. C. M., & Bolhuis, S. (2007). Experienced Teacher Learning within the Context of Reciprocal Peer Coaching. *Teachers and Teaching: Theory and Practice*, *13*(2), 165-187.

Wang, X., Kim, B., Lee, J.W.Y. & Kim, M.S. (2011). Developing an epistemic community in the classroom as teacher development. In S. Barton et al. (Eds.), *Proceedings of Global Learn Asia Pacific 2011* (pp. 1272-1281). AACE.