Influence of professional learning community (PLC) on learning a constructivist teaching approach (POE): A case of secondary science teachers in Bangladesh

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Abstract

No major change has occurred up until now with regard to the teaching-learning methods of science used in Bangladesh. Teachers, in most cases, tend to teach the

same things in the same ways they were taught when they were students. This study will, therefore, investigate how science teachers' learning in a professional learning community (PLC) influences the ways in which participant teachers learn about a constructivist teaching approach (POE). In so doing, teachers also work towards forming a professional learning community within and across schools. This article presents participant science teachers' understanding after they attending an intervention. Data have been drawn from 14 voluntary participant science teachers who were formed into seven peer pairs, from seven schools in Bangladesh. Each pair of teachers was located at the same school. The findings of this research show that the use of a constructivist teaching approach (POE) encouraged participant teachers to change their teaching perceptions which had been based on a traditional (didactic) approach. The findings of this study ultimately carry implications for science teachers' practice in using the POE and the collaborative activities empowered them to share, which expanded their capacity to develop a personal vision for their own teaching practice.

Keywords: Professional Learning; Professional Learning Community (PLC); Constructivist views of Teaching; Secondary Science Teachers; Bangladesh

Introduction

Professional learning community, (PLC), in general, focus on the process of learning for improvement and change in schools (Alberta Education, 2006; Kruse, Louis & Bryk, 1994). A PLC consists of a group of people who take "an active, reflective, collaborative, learning-oriented and growth-promoting approach toward both the mysteries and the problems of teaching and learning" (Mitchell & Sackney, 2001, p.2). A PLC is also defined in terms of an "educator's commitment to working collaboratively in ongoing processes of collective inquiry and action research to achieve better result for the students they serve" (DuFour, DuFour & Eaker, 2008, p.14). In essence, a PLC is explicitly a place where caring, responsible people nourish others' learning in the context of authentic interactions (Manzaro, 2003; Miller, 2000). In most cases, participants involved in a PLC become more intellectually mature and responsible for their learning. They like to develop the capacity to care about the learning of their peers and are focused on collegiality and professionalism (Manzaro, 2003). Moreover, PLCs offer teachers the possibility to

connect with one another within and across the school in order to improve students' learning outcomes and their own professional learning (Roberts & Pruitt, 2009).

Problem of the Study

Quality education, especially in science education at the secondary school level, remains a major concern (Ministry of Education, 2005) in Bangladesh. Throughout at least the last two decades, measures have been taken to change science teaching practice mainly through government and donor funded projects. However, no major change has occurred up until now with regard to the teaching-learning methods of science used in Bangladesh (Tapan, 2010). Teachers, in most cases, tend to teach the same things in the same ways they were taught when they were students. In most cases, teachers' presentation style in science classrooms is unappealing to students (Choudhury, 2008). Moreover, according to Maleque, Begum and Hossain's (2004) study, most of them (85%) are not confident about using appropriate teaching strategies in their science teaching and are very reluctant to use new methods of teaching due to a lack of motivation, interest and proper training and follow up (Tapan, 2010). Even now science is taught everywhere in Bangladesh using traditional teacher-centred methods with less importance paid to student participation and interest. Largely, teachers encourage students to rote learn and encourages students to memorise textbook material rather than understand science concepts or develop any kind of personal knowledge construction (Asian Development Bank [ADB], 1998; Tapan, 2010).

The above situation makes the classroom learning environment very likely to be dominated by a teacher centred approach thus minimising the likelihood that students' interest in learning science will be aroused (Hossain, 1994). In most cases, teachers are not cognisant of the need to take into account students' prior knowledge in terms of influencing their practice. It is also very rare to find teachers sharing ideas with each other to improve their practice. This situation triggered me to decide to ask science teachers to use a constructivist teaching approach, prediction-observation-explanation (POE), in their practice. My understanding about the use of POE was that it guides teachers in their thinking about subject knowledge and pedagogy and creates new ways of sharing and discussing with their colleagues. Moreover, from the ideas from Gunstone (1995) regarding the importance of genuine collaboration (teacher with teacher, teacher with researchers)

in the development and use of constructivist teaching approaches, I found myself becoming more focused and guided in ways that supported my thinking and my plans for action. Therefore, in order to support their learning about this strategy I also designed teacher collaborations within and across nearby schools (described in detail in method section).

Purpose and Research Questions

The present study thus offers an exploration of how secondary science teachers' learning in a professional learning community influences the ways in which participant teachers learn about a constructivist teaching approach. To address this issue, this paper sets two research questions. These are,

1. To what extent do participant science teachers engage in a Professional Learning Community?

2. How can establishing a Professional Learning Community influence the ways in which these teachers learn about a constructivist teaching approach (POE)?

Theoretical Framework

Constructivist Views of Science Teaching and Learning

A constructivist view of knowledge and learning has led to changes in teaching approaches in science education. These ideas have had a major influence on the thinking of science educators over the last two decades (Fensham, Gunstone & White, 1994). Students come to class with their existing ideas from which they make sense of their world. Science teaching needs to lead students to interact with these ideas by making them explicit and then promoting consideration of whether or not other ideas make better sense (Carr et al., 1994). From a constructivist teaching point of view, the main concern in teaching science is "how to organize the physical and social experiences in a science classroom so as to encourage development or change in learners' conceptions from their informal ideas to those of accepted school science" (Scott, Asoko, Driver & Emberton, 1994, p.201). Constructivist teaching involves "judgments about how much and what form of

guidance is best for any topic and any group of learners, and when to provide it" (Fensham et al. 1994, p.6). The teaching procedure, Prediction-Observation-Explanation, is one such approach.

Prediction-Observation-Explanation (POE)

Prediction-Observation-Explanation (POE) is a constructivist teaching strategy developed by White and Gunstone (1992). The POE strategy is often used in science teaching. It requires three tasks to be carried out. First, this strategy helps to uncover individual students' predictions, and their reasons for making these about a specific event. Second, students describe what they see in the demonstration - observation. Third, students must reconcile any conflict between their prediction and observation – explanation. POEs can therefore be used to explore students' ideas at the beginning of a topic, or to develop ideas during a topic, or to enhance understanding at the end of a topic (Gunstone & Mitchell, 1998). Through this teaching procedure, students are assisted in attempting to apply their learning to a real context. It is not about telling students the right answer at the end (Loughran, 2010). Moreover, this strategy focuses on linking students' existing ideas and beliefs relevant to a situation and exploring the appropriateness of these ideas and beliefs (Gunstone, 1995).

Attributes that Characterise Professional Learning Communities

The research-based literature on the attributes that characterise PLCs has grown up over the last couple of decades and much of that literature centres on Hord's (1997) research-based characteristics of PLCs and the work of Dufour and Eaker (1998). At the same time, PLCs have also been influenced by Senge's (1990) notion of learning organisation and culture. The other significant contributions have been that of Kruse, et al. (1994), Berlinger-Gastafson (2004) and Patterson and Rolheeiser (2004). The Annenberg Institute for School Reform (Annenberg Institute for School Reform, 2003) and Alberta Education (2006) also worked toward system wide reform and change initiatives. The following section discusses this literature in more detail.

Supportive and Shared Leadership Capacity

One of the defining characteristics of a PLC is that of power, authority and decision making as being both shared and encouraged (Hord & Sommers, 2008). It is also a

common understanding that teachers find it difficult to propose any new ways of thinking and doing when the school or head of the department/principal is viewed as unwilling to share power. However, PLCs are places where both the principal and teachers are learners and distributed leadership positively impacts the situation (Hargreaves & Fink, 2006). Shared leadership structures are therefore important in PLCs. Hord (1997) emphasised shared leadership structures in which participants in PLCs have the ability to question, investigate and seek solutions for school improvement. Barth (2006) described a culture of collegiality for developing this attribute where participants share with others about their practice; share their craft knowledge; observe others' practice and investigate for one another's success

Shared Mission, Vision, Values and Goals

Shared mission, vision, values and goals are considered as a collective focus on and a commitment to student learning (DuFour, et al., 2008; Hord & Sommers, 2008; Kruse, et al., 1994). When schools work as PLCs, teachers find themselves with a fundamental responsibility for their students' achievement. To attain this shared purpose, participants are encouraged to be involved in the process of developing a clear and compelling vision that works as a guidepost in decision making about challenges they face in schools on how their collaboration must contribute to their students' learning. They ultimately build collective commitments that clarify the responsibility of individual teachers' contributions to their students' learning.

Collective Learning and Its Application

A PLC is a place where participants find opportunities to study together and work collaboratively (Hord & Sommers, 2008). Teachers expect that all students can learn at reasonably high levels as a consequence of their collaborative work. In practice, it does not happen due to different types of obstacles that students face outside the teaching institution. However, these opportunities help them to be involved in a continuous learning process and apply what they have learned to their practice. Such a collaborative process mainly emphasises the need to seek new knowledge collectively (Hord, 1997). Moreover, this collective learning is the "process of aligning and developing the capacities of a team to create the results its members truly desire" (Senge, 2000, p. 236).

Shared Personal Practice

Teachers need appropriate environments for their professional learning (Hord, 1997; 2004). Such environments value and support "hard work, the acceptance of challenging tasks, risk taking, and the promotion of growth" (Midgley & Wood, 1993, p. 252). Shared personal practice is one of the attributes that contributes to the development of such a setting for teachers' professional learning and sensibly can be considered as one of the conditions that supports a professional learning community (Hord, 1997; Pickering, Daly & Pachler, 2007). For this purpose, teachers review each other's practice (Hord, 2004) and behaviour (Hord, 1997, 2004; Kruse, et al., 1994) in their daily practice. There is a focus on a "peers helping peers" process (Hord, 2004, p. 11), not on any evaluation of teachers' learning or teaching (Hord & Sommers, 2008). Teachers conduct this review through visiting each other's classrooms on a regular basis to observe, write notes, discuss their observation with their visiting peers, as well as through staff meetings and specifically designed planning sessions (Hord, 1997; 2004; Patterson & Rolhiehieser, 2004).

Another purpose of shared personal practice is to support the adoption of new teaching practice. Members help each other to adopt a new teaching strategy through action research, coaching, mentoring, feedback, collaborative and collegial decision making (Alberta Education, 2006; Hord, 2004). In most cases, they use notes for discussion purposes during the feedback. Members also use these discussions to critique themselves.

These critiques can go in several different directions but are mainly focused on subject matter knowledge and the teaching strategies usually employed (Kruse, et al., 1994; Louis & Kruse, 1995). They also examine and question their existing teaching practice (Patterson & Rolhiehieser, 2004). They even encourage debate, agreement or disagreement about their teaching practice (Hord, 1997; Wignall, 1992). This allows for sharing of both failures and successes (Hord, 2004) and for analysing the problem for taking action (Patterson & Rolhiehieser, 2004). This ultimately brings a level of accountability, pressure and support for adoption of teaching practices to the members of PLCs through shared personal practice. The characteristic sharing of understanding and experiences of personal practice is, of course, directed toward improvement of both teaching and professional learning.

A Commitment to Continuous Improvement

The current focus of learning communities is on documenting evidence of improved practice of teachers (Annenberg Institute for School Reform, 2003). Schools need to develop strategies for documenting how teachers work together in PLCs to improve their collective practice. Teachers work within a learning community to develop a process to identify, collect and analyse specific examples of changes made in their practice. They participate in either grade-level or subject-area meetings, communicating with colleagues about their teaching and learning decisions and practice (Morrissey, 2000). These ultimately impact on the culture, norms and outcomes to show evidence that the professional learning community works to improve teachers' learning experiences. However, a PLC also needs appropriate support to make it successful.

Supportive Conditions

Supportive conditions determine "when, where, and how the staff regularly come together as a unit to do the learning, decision making, problem solving, and creative work that characterise a professional learning community" (Hord, 2004, p. 10). These are basically considered as logistics of PLCs (Hord & Sommers, 2008). Kruse, et al., (1994), Boyd (1992) and Berlinger-Gustafson (2004) worked to identify several categories that must be met in order for a PLC to be effective. These categories can be grouped in two categories: (1) Structural and physical factors regarding logistical conditions; and, (2) the Relational factors and human capacities which deals with the capacities and relationships developed across the participants (Hord & Sommers, 2008). The necessary conditions for physical and structural factors as mentioned by Kruse, et al. (1994) are time to meet and talk, physical proximity, independent teaching roles, communication structures, and teacher power and empowerment. The significance of the relational factors and human capacities which are considered social resources in a productive learning community is that they address teachers' enthusiasm to acknowledge feedback and work for improvement (Boyd, 1992; Hord, 1997; Kruse, et al., 1994).

Research Method

Strategy of Inquiry

This study followed a qualitative approach. The main purpose was to explore how secondary science teachers' engagement in a learning community influences the ways in which participant teachers learn about a constructivist teaching approach (POE).

Research Design

To address research questions (RQ1 & RQ2) of the study, I used a series of interventions. However, introducing an intervention may be effective in resolving school changes or problems (Murphy & Duncan, 1997; 2007). As change is a process, not an event, effective change takes time (Fullan, 1982) and substantial value can be gleaned from the efforts associated with an intervention (Robson, 2002). In this study, the interventions combined the following items sequentially.

1. Using a new constructivist teaching approach Predict-Observe-Explain (POE)
2. Observing colleagues' teaching practice
3. Reflecting on classroom observation schedule
4. Attending a post-teaching discussion
5. Attending a professional workshop

Firstly, participant teachers were introduced to a constructivist teaching approach Predict-Observe-Explain (POE) which they were expected to use as part of the intervention. This teaching approach was not familiar to them before my introduction. The purposes of this strategy was to help teachers to: change their perceptions about what might be useful in finding out students' initial ideas; provide teachers with information about students' thinking; generate discussion; motivate students to want to explore the concept; and, generate investigations (Palmer, 1995; White & Gunstone, 1992).

Secondly, the peer classroom observation process had as a fundamental purpose the gathering of meaningful information as it was essential that both the teachers and observer learnt from one another through this classroom observation process.

Thirdly, the information they gathered from peer observation could then be used to learn about and, reflect on the classroom observation schedule, and improve their instructional behaviour (Sullivan & Glanz, 2000). This ultimately helped them to construct shared pedagogical understandings about a new constructivist teaching strategy (POE). Moreover, the reflection on the schedule served as a basis for the subsequent post-teaching discussion.

Fourthly, the purpose of arranging the subsequent post-teaching discussion was to reconstruct the meanings from the classroom observations about different pedagogical aspects. Finally, attending the professional workshop provided scope to refine understandings through interaction with a comparatively broader community. One of the purposes for arranging these workshops was to raise and discuss issues that were undecided or were notable from individual peer pairs. One of my expectations for the outcome of the professional workshops was that participant teachers might be able to resolve or explain any issues that were listed for discussion in the workshops that persisted in their minds as concerns or unresolved issues. From classroom teaching to attending professional workshop constituted a cycle. In this research, I conducted this cycle twice, in order to better understand the intervention and possible changes to teachers' learning about a new constructivist teaching.

Selection of Science Topics for the Intervention

Participant teachers were asked to identify topics from their secondary science classes which could be suitable to teach using the POE approach as an intervention. From the many topics proposed, the final selection of topics was completed (as outlined in Table 1 below). All participant teachers agreed that the four selected teaching topics involved higher order thinking.

Table1. Final Topics for Teaching Using the Intervention

Teaching session	Teaching Topics	Content Area	Target Grade	Page on The NCTB text book
One	The pressure of a liquid	Physics	Grade Seven	22
Two	Saturated and unsaturated solutions	Chemistry	Grade Seven	94
Three	Refraction of light	Physics	Grade Eight	145
Four	Human Brain and its function	Biology	Grade Eight	263

Participants

I used 'convenience' sampling to select 14 secondary science teachers from seven nearby schools from those who volunteered to be further involved in the study. The consideration was based on availability, easy recruitment and willingness to participate in the study (Mertens, 2010; Robson, 2002). Moreover, the nature of the intervention demanded participants from nearby schools within a local area of Ashuganj UpaZilla of Brahmanbaria district of Bangladesh in order to make further involvement easy for participants and to attend the follow up professional workshop. Each individual peer pair then followed up through classroom observation, post-teaching discussion and professional workshops to see how ideas from different components of the intervention influenced their science teaching practice.

Research Instruments

This particular article use qualitative research tools, namely, a post-intervention open ended questionnaire, Focus Group Discussion (FGD) and notes from post teaching discussions and professional workshops. Basically, the questionnaire was used to ascertain participant teachers' views regarding the intervention. The purpose of the FGD was to complement the post-intervention questionnaire and allowed participant teachers to reconsider their thinking about the outcome of the intervention.

Data Analysis

In analysing data, the post-intervention questionnaire, FGDs and filed notes were transcribed and analysed using NVivo 8. In this case, For analyzing qualitative data, I employed "data transformation" procedure, namely, quantifying qualitative data approaches under selected themes. (Creswell, 2009). For this qualitative data was coded into different themes that informed the research questions. These codes were then assigned numbers and the number of times codes arose were tabulated as numeric data (using NVivo 8). At first, responses from all 14 participants for individual questions were accumulated together and analysed accordingly under different themes to elicit quantitative values. Secondly, the quantitative values for each individual issue from the questionnaire was then crosschecked with the responses from both FGDs to confirm issues around which there was consensus or disagreement in terms of their understandings about any issues of the intervention

process. In so doing, I first developed a general sense of the data through reading all the transcriptions. Then I selected text segments under different sub-themes using NVivo 8. Then I merged all the sub-themes into individual themes that captured the major categories of information. The results were then reported as descriptions on the basis of responses both from the post questionnaire and FGDs in response to the respective research questions. This analysis guided the determination of the key characteristics to identify how teachers learn to use a constructivist teaching approach collaboratively in their practice.

Results

This section looks at the results from the post intervention questionnaire, focus group discussions (FGDs) and notes from post teaching discussions and professional workshops used in this study to elicit the teachers' understandings the influence of PLC on their experience with the new teaching strategy (POE).

Teaching With an Observer Colleague

It has already been mentioned that 14 volunteer participant science teachers were involved and formed seven peer pairs, from seven nearby schools. Each pair of teachers was located at the same school. None of them had any experience of observing a full period of their colleagues' teaching or conducted any teaching with an observer colleague before. According to Teacher 3 before the first teaching session cycle:

I am teaching for the last 23 years. This is the first time I am going to a class in where my science colleague is also ready to observe my full class. It really helped me concentrating on my lesson today using a new teaching approach POE. I am sure the presence of my colleague would helpful to find whether I am going to make any mistake during my teaching.

It seemed to me that most of the teachers felt nervous during the first teaching session. They were hesitant and were concerned about their colleague's presence rather than concentrating on the lesson. However, that was not the case for the observers in the teaching sessions. According to the Teacher 4, after observing the teaching practice of his colleague:

It is the first time I observed the teaching practice of my colleagues. I was really excited yesterday. The observation has helped me to see my colleague's teaching method, style of presentation and how he engaged students in the lesson. It also helped me to reflect on and clarify of my own teaching.

It seemed to me that in most cases they were excited about finding scope to observe their colleague's teaching using POE. It is notable that, before and after the first teaching session, all the participant teachers expressed the view that they liked the idea of observation. Most of them responded that this idea would help them to improve their own teaching practice using POE strategy. Moreover, teachers found this process as a good way of integrating two teachers' experiences. According to Teacher 10 during the FGD:

The classroom observation process seems very essential for us. It is not possible to find out my own problem by myself, if any of my science colleagues help me through observing my class, it is really great ... it also helps to learn POE strategy properly ... find scope to integrate the two teachers' experiences for enhancement of both the content knowledge and pedagogical understanding.

Attending the Discussion Session

The participant science teachers found scope for discussion after completing the reflection on the observation schedule. During the discussion time, teachers found themselves both in agreement and disagreement with their colleagues, challenging each other's reflections or observations and sometimes feeling confused while engaged in debates about some aspects of their peers' teaching issues. For example, Teacher 6 disagreed with the observation for not accomplishing the 'observation part of POE' properly. He noted that he allowed students to observe the human model instead of any real brain to reconcile any differences between the prediction and the observation.

Teachers also discussed about their different concerns and observations about using a POE. Teacher 12, during the first teaching cycle, discussed with teacher 11 about the mismatch of the prediction part of the POE. According to him, teacher 11 explained what would happen before allowing students to predict about the experiment. He also mentioned that teacher 11 did not ask students to write the reasons for their prediction. Teacher 14, during the third teaching cycle, claimed that teacher 13 went very fast when students were making predictions. Moreover,

teacher 11, during the fourth teaching cycle, claimed that teacher 12 could ask students to draw pictures of the brain from their perception to elicit their preconception about the brain.

In seven cases, mostly during the first and second teaching cycles, the observers claimed that during the discussion that students did not have enough opportunities to reconcile the difference between their observation and prediction. Teachers themselves tended to do the explanation rather facilitate students' attempts at reconciliation. However, as noted, the discussion helped teachers to make that adjustment during the third and fourth teaching cycles.

These above examples reflect how discussion helped these teachers to develop their teaching using the POE approach. These discussions helped them refine their ideas about POE and how it might be used in their teaching more effectively.

Attending Professional Workshop

In all professional workshops teachers discussed the use of the POE teaching procedure. In the discussions, some of the teachers conflated 'prediction' and 'observation' of the POE during the first teaching cycle. Teacher 9, then, demonstrated the importance of the distinction between the two parts using the same teaching topics of teaching cycle one. Teachers also discussed the use of POE across different experiments to clear up issues about the concept of refraction during the third professional workshop. They also discussed and were happy to know that teacher 11 used a live fish in a bowl of water as a demonstration experiment. According to teacher 11:

I got the ideas in sharing with science colleagues of my school. One of my students helped me to find a live fish as his father is a fisher man. This made the class very different from usual classroom learning; students were so motivated with a high [level of] attention in the classroom.

Other teachers were very impressed with such thinking and also discussed how to provide more scope to students to reconcile differences between their predictions and observations. These examples reflect how collaboration through attending the professional workshops addressed teachers' everyday issues through discussions with their colleagues as a result of changing the culture of their professional practice.

Influences on New Teaching Approach (POE)

Participant teachers used the POE teaching strategy for their science teaching at the intervention implementation stage. Teachers expressed their opinion on several aspects such as their feelings about POE, their understanding about the use of POE, aspects after using it, its influence on their teaching practice, problems regarding using the POE strategy, its effectiveness in the Bangladesh context and suggestions for its effective use. They demonstrated consensus as all 14 participating teachers found the POE to be a very effective strategy in their science teaching. Their major responses are listed in the Table 2.

Table 2. Teachers' Feelings about the POE Strategy

Responses	Frequency (Number of Teachers)
Provided scope to these teachers to consider their students' prior knowledge.	4
Related the science content to real life.	3
Involved students in thinking for learning.	5
Clarified the concept with a logical conclusion.	3
Discouraged students from memorising science concepts.	2
Made students attentive in their learning.	4

More specifically, according to Teacher 5:

> The teaching with POE is very good to me. It seems to me that it is a fruitful and effective strategy for science teaching. POE is more effective than any other method I had ever used. It helped to develop students' thinking power. It made a connection of learning with real life that made learning more sustainable. It also helped me to concentrate more on the teaching topics and to make students more attentive. Students were discouraged to memorise the science through direct observation in the classroom.

Teachers were asked what using a POE did in terms of encouraging them to pursue different purposes in their practice. They listed diverse characteristics. Among them seven teachers mentioned that they used it because it created a sense of reality and that it led to students making connections with science and the environment

around them. Six of them used it because they thought it helped them to make students attentive in their learning in a way that was very effective for large class size. In Table 3 lists the major responses of participant science teachers.

Table 3. Objectives of POE According to the Participant Teachers

Responses	Frequency (Number of Teachers)
POE strategy links to reality and makes connecting science with the environment much easier for students.	7
POE strategy helps teachers make students attentive in their learning which is very effective for a large class size.	6
Making students think about their learning.	4
Takes into account students' prior knowledge.	3
Helps students to acquire accurate knowledge about science concepts.	3
Guides the lesson in a logical sequence.	4
Makes students develop a creative attitude.	3
Encourages the exploration of alternative conceptions – brings out prior knowledge.	2
Develops self-confidence for teachers.	3

Teachers made a list for the good aspects of a POE from their experience after using the strategy. Among them, 10 teachers pointed out that a POE is a very good strategy as it allows students to think independently and to express their own opinion. This ultimately helps students to be self-confident and develop a self-directed learning attitude. Eight teachers expressed the view that POE was able to make students attentive in their learning and helped them to teach a large class size effectively; which is very important from a Bangladeshi perspective. Six teachers gave priority to considering students' prior knowledge through prediction. This also helped students to make a decision about science knowledge through analysing their prior knowledge with the help of direct observation in the classroom. Six teachers also mentioned its power in making a connection with real life through using teaching aids, demonstrations and observation. Moreover, four of them mentioned its power in helping students understand about their alternative

conceptions in their prior knowledge and acquire more accurate science knowledge. More specifically, according to Teacher 2:

> POE is a very good strategy to elicit students' alternative conceptions about science concepts. At first students predict for a science concept based on their prior knowledge. However, when they saw something different during the observation stage, they can easily realise that they have some problem in their own prediction. I found some of them during my two teaching session with POE.

Teachers also experienced influences from using the POE strategy in their usual science teaching practice. Eight teachers mentioned that the strategy helped them to make the lesson interesting, which leads students to be more attentive in their science learning. Six of them were of the view that using this strategy helped them to make sure that they came into class well prepared. This greater preparation included being more confident in their content knowledge, their use of teaching aids and making more links between the science concepts and real life. The major responses are listed in the Table 4.

Table 4. Influences of POE Strategy on Teachers' Practice

Responses	Frequency (Number of Teachers)
Led students to be attentive in their science learning.	8
Made the lesson interesting.	8
Helped them in class preparation.	6
Ensured use of teaching aids.	3
Developed thinking ability.	3
Integrated real life with the text book.	5

Problems in using POE

Teachers also outlined their problems in using POE within their practice. Eight teachers mentioned straight away that they did not find any difficulty in using POE. Five teachers mentioned that they believed that POE would not work for all topics, especially for topics which required a deep theoretical understanding. For example, one of them doubted that using a POE strategy would be useful for the basic understanding of electricity. Four teachers wondered how they would manage to

use a POE with their existing teaching load. During the FGD, they also discussed the issue of class size. However, according to Teacher 13, "I did not find any problem with class size in using POE in my classes. I think it is the strategy that makes students active together." The other teachers then agreed with him.

Teachers also expressed their opinion on the workability of this strategy in the Bangladesh context. Twelve teachers recommended its use for the Bangladesh secondary school context because they felt it was an effective teaching approach. According to them, the POE strategy would help science teachers find a link between the text book materials and the local environment around the school. This could happen through searching for appropriate teaching aids for their practice because of the use of a POE. Moreover, they discussed at the FGDs that as there is an ongoing problem with large class size and POE is an effective strategy to make attentive a larger number of students, which this method could work well as an effective approach for science teaching in Bangladesh.

However, two teachers were sceptical about the effectiveness of POE in the Bangladeshi context. They were concerned about the need for good preparation for a POE when teachers were usually loaded with classes. They were also concerned about adequate support for using the POE in their practice especially in regard to the lack of school resources. In spite of this, during both FGDs, other teachers disagreed with that view. According to Teacher 10, "Bangladesh is a developing country; we have to look forward rather than waiting to depend on others. We have to work hard to find our resources. I think for the secondary level, we can find all of our resources from our local environment with a minimum effort." The others agreed with him.

Teachers also offered suggestions for the effective use of POE in the Bangladesh context. Most of them asked for support from schools as much as possible besides teachers' own initiatives. This mainly included the use of adequate resources for teaching. Teachers also stressed the importance of good preparation before taking any class. According to Teacher 6:

> Teachers need to be well prepared both in content clarification and using the teaching aids. The most important issue here is the chance of rising up alternative conceptions. When students find themselves in [a feeling of] difference between the prediction and observation, they could be lost. They

might look for proper facilitation form their teachers that demand a strong command of subject knowledge.

Six other teachers attached importance to changes in the culture of their professional practice and the need to develop an attitude for accepting any new teaching strategies. According to them, teachers needed to change in ways that could benefit their students' learning. Three of them pointed out about the need not to keep teaching in the same way as they had for year after year. They also suggested reducing their pressure regarding teaching load.

The above results reflect that how establishing a Professional Learning Community influences the ways in which these teachers learn about a constructivist teaching approach (POE).

Discussions

This section of the chapter discusses the influence of establishing a professional learning community among the participant science teachers. It has already been mentioned that through the intervention these teachers were supported in attempting to develop PLCs to encourage and help to improve their practice by using a new constructivist teaching approach (POE) and therefore enhance their students' learning of science. The discussions also sought to find out influences on the ways in which these teachers learnt about, and developed, their practice.

The intervention process allowed them to observe a full period of classroom teaching, discuss their observations with their colleagues and attend the professional workshops. These various opportunities helped teachers feel more comfortable to share their feedback with their colleagues. These teachers enjoyed opportunities to share and critique their colleagues' practice and also to reflect on their own practice in relation to identifying positive and negative aspects of their teaching with POE. It is evident that initially these teachers felt shy or hesitant in sharing; however, gradually they realised that it helped them to improve their teaching and they felt more comfortable in so doing in the latter part of the intervention implementation stage. Teachers' increased confidence may be due to collaborative activities where they found good supports and ways to improve their teaching practices. The collaborative process allowed them to expand their capacity in developing a personal vision for their own teaching practice for enhancing

student learning (Senge, 2000). As a consequence of their experiences, these teachers may well find in the future that they have now developed ways of working together as a teaching community based on collaborative approaches rather than a state of isolation.

The participant teachers used post-teaching discussions and professional workshops to guide their decision making about the challenges they faced regarding their practice. Participant teachers therefore engaged in the collaborative activities to improve both their practice and their students' learning. These activities assisted them in identifying and overcoming their perceived difficulties with their teaching. The intervention process engaged them in the process where their commitment to improving their practice helped them to envision enhancing their students' learning. Moreover, their professional commitment through continuing their collaborative activities worked to ensure the promotion of a shared mission with a meaningful focus (Patterson & Rolhiehieser, 2004).

The collegial effort through learning and reflection also guided these teachers to be devoted to using a new teaching strategy (POE). For example, using the POE guided them to see that they might also have alternative conceptions regarding science concepts, just as their students do. This realisation was important to them as the majority of these teachers were not familiar with alternative conceptions in science before they became involved in this research project.

It is evident from the data that initially some participants found the POE approach hard to use as they had difficulty maintaining the right sequence. However, these teachers overcame their difficulties by seeking and receiving suggestions from their peers and more generally from the workshops they attended during the intervention process. Their commitment to incorporate the POE strategy into their practice was most evident in which they realised these collaborative processes helped them to refine, strengthen and rethink the use of the strategy for future practice. Their learning about their teaching therefore occurred through collaboration with their colleagues.

The process of shared personal practice also guided teachers to act as 'change facilitators' for individual and school improvement. This basically helped them to encourage and support each other. It is evident participant teachers also supported each other to adopt a new teaching strategy (POE) during the intervention process.

They discussed failures and successes in implementing this teaching strategy and discussion helped them to facilitate students' involvement in their learning during the third and fourth teaching cycles.

It has already been mentioned that the intervention process offered these teachers the opportunity to observe each other's classes. After that, individual peer pairs within a school joined a post-teaching discussion. After completing each teaching cycle all of the teachers attended a professional workshop. These opportunities allowed them to spend some time to meet with their colleagues and talk about their teaching practice in establishing supportive conditions for a PLC.

The schedule and structure offered by this intervention also helped to reduce the state of isolation among these teachers that is a very common complaint for teachers in Bangladesh. This structure may have helped these teachers to come together as a unit to do the learning, and support decision making, problem solving, and creative work in ways that characterise a professional learning community (Hord, 2004). These processes also highlight the importance of time and support for learning as variables for school improvement. Overall this process helped them work towards achieving the school mission by providing a caring and productive environment and, improving the quality of the school program (Boyd & Hord, 1994).

Implications

The findings of this research revealed that participant teachers found it difficult to set challenging goals and to use hands-on teaching methods that involved collaborative activities with others. However, through using the POE and collaborating with colleagues they found themselves much more confident in developing and using hands on activities. The collaborative activities empowered them to share, which expanded their capacity to develop a personal vision for their own teaching practice.

Moreover, they had opportunities to seek understanding regarding the use of resources from multiple sources in order to implement the POE strategy. In most cases, they used local materials rather than any sophisticated teaching aids in order to develop a conscious awareness of the science concepts to be learnt for their students. The intervention process worked as a motivating agent to use more

teaching aids in their practice. Moreover, they shared their teaching aids and suggested ways to find and use teaching aids through collaborative activities. This means that it could be helpful to think about using more teaching aids to develop a sense of purpose of their students and it would obviously be more worthwhile if they concentrated on collecting more from the local environment rather than rely on sophisticated aids as one way of counteracting the weak financial situation of their schools. Moreover, it could also be helpful to think about how to create a more collaborative culture in supporting the development of practice.

Conclusion

The findings of this research show that the use of a constructivist teaching approach (POE) encouraged participant teachers to change their teaching perceptions which had been based on a traditional (didactic) approach. These teachers experiences of using the POE approach guided them in changing their views about collecting and using teaching aids in their practice. The collaborative activities amongst their colleagues within and across the schools helped them to re-examine and reconstruct their understandings of teaching and its relationship to student learning. Moreover, the findings also show that the development of the idea of a PLC reinforced the value of professional learning through job-embedded learning. Moreover, the ideas from Gunstone (1995) regarding the importance of genuine collaboration (teacher with teacher, teacher with researchers) in the development and use of constructivist teaching approaches had confirmed for Bangladeshi science teachers.

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