European Online Journal of Natural and Social Sciences 2022;
Vol.11, No 4 (s) Special Issue on Hybridity in the New Reality
ISSN 1805-3602

Productive Lesson Study towards Quality Professional Development for Science Teachers

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Abstract

The study was conceived as a professional development of teachers towards quality teaching using Lesson Study (LS) and Productive Pedagogies (PP) as a as a framework to plan for lessons and to reflect on classroom teaching. The aim of the study was to investigate the level of adoption by the teachers of both the LS and PP principles. The intention was to investigate the teachers' experiences in such a professional development activity and identify the benefits and arising problems with a focus on their understanding of teaching and change in their practice. After the intervention, it was evident that teachers have gained some knowledge about their teaching and about their students. Nevertheless, there remain concerns about some of the issues in need for further work: deep and functional content knowledge; better connection between the different components of lessons; questioning techniques; and a variety of teaching methods that allow for greater student engagement at a higher level of thinking.

Keywords: Lesson Study, Productive Pedagogies, Professional Development, Science Education

Introduction

Lesson Study (LS) is an internationally arising method for studying and improving classrooms and professional development of teachers [1-3]. In spite of evidence about its effectiveness, LS is sometimes critiqued for lack of a theoretical basis to reflect on lessons and on teaching. Hence, this study builds on the experience of the country and internationally, by integrating Productive Pedagogies (PP), a framework developed in the State of Queensland in Australia to investigate whether an introduction of a common language to discuss teaching might assist teachers in changing their practices towards quality teaching.

The main objective of this study was to develop, implement and evaluate a professional development of elementary Science teachers in one school in Antipolo City (Philippines) using LS process and the PP framework. In particular, this study aimed to investigate:

1. The level of adoption of the Science teachers to the LS and PP as means of their professional development;
2. The range of Science teachers' learning and change in their practice resulting from such a professional development program; and
3. Identify benefits and challenges in the use of such a methodology in the context of low SES school and community.

Adhering to the notion that quality teaching and quality teachers are essential for improving educational outcomes of Filipino students [4] and that an effective way to achieve quality teacher is through reflection and support of a community of practice [5], this study is guided by a conceptual framework that is modelled by the diagram in Figure 1.

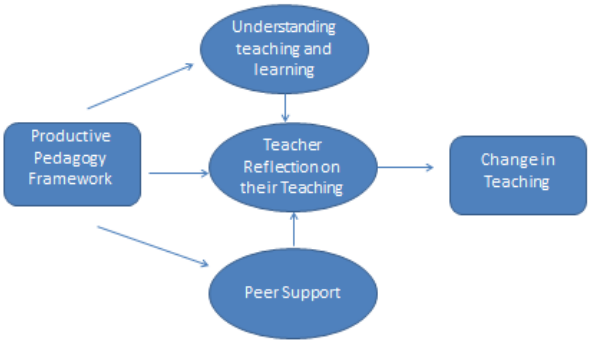

Figure 1. The conceptual framework illustrating the main variables in the study.

Moreover, the model illustrates that PP is a framework that assists teachers to focus on aspects of their teaching that has been widely used in many countries around the world [6].

Review of Related Literature

This section presents PP is a framework that assists teachers to focus on aspects of their teaching that has been widely used in many countries around the world [6]. Thereafter, a discussion on LS is presented as a teacher professional development model that is deemed to potentially provide teachers with a platform for inquiry and learning in their practice [7].

Productive Pedagogies (PP)

PP provides a theoretical framework that enables teachers to plan and reflect critically upon their current classroom practice with the use of professional vocabulary that could engender conversations about teaching practice vis-à-vis students' needs [8]. Mills [9] posited that although the focus of metalanguage was the classroom, realizing high quality outcomes for students will require more than teachers simply changing their practices; but they also need the support of school communities and the systems within which they are situated.

The PP framework represents a strong commitment to social justice in education. Lingard and Keddie [10] noted that the framework conjoined Nancy Fraser's conceptualization of politics of redistribution, recognition, and representation as her principal components of social justice. With this framework, pedagogies are differentiated to support the role of schooling as a positional good, a good in itself, and a good towards the betterment of the broader social world.

An exploratory paper [11] argued that teachers need to use more PP to improve students' learning; it is proposed that teachers need to be more radical to be effective. They also need to consider the way in which they might be producer of their own acts of learning within professional learning communities (PLCs). It also looked at how professional learning communities can support teachers in producing learning and how through PP in professional learning communities can develop teachers as educational leaders within the act of learning.

A further study [12] explored whether PP provides a feasible alternative to existing frameworks for teacher development. The study argued that with its four dimensions of "intellectual quality", "relevance", "social support" and "recognition of difference", the PP framework clearly attends to both the intellectual and the social justice outcomes of the students.

Lesson Study (LS)

LS is a form of teacher professional development that originated in Japan and has been cited as key factor in the improvement of their mathematics and science education [2]. LS follows a cycle of instruction improvement in which teachers work together to formulate goals for student learning

and long-term development. LS is a process that follows an iterative cycle by which teachers collaboratively work on a shared goal or inquiry focused on students' learning or formulation of local theories on mathematics teaching and learning, plan a lesson that would allow for an exposition of these learning or a testing of conjectured local theories, then jointly examine and discuss on the enactment of the lesson as observed [13]. The live/actual lesson prepared and observed for the purposes of LS is called Research Lesson (RL). The collaboration comes in different levels in different stages. Teachers of the lesson planning group collaborate during the preparation periods that include goal-setting. Other teachers from other departments or schools and researchers collaborate as they observe lessons and contribute in the discussions during the post-lesson defriefing.

Teachers collaboratively plan a RL designed to bring to life the goals of lesson study. They conduct the RL with one team member teaching and others gathering evidences on student learning and development. They discuss and reflect on the evidences gathered during the lesson (called post-lesson discussion or debriefing). Then, they use it to improve the lesson, the unit, and more generally, the instruction [14].

The post-lesson discussion is one of the most distinctive characteristics of this type of professional development. It provides a means of discussion that will pave the way for reflecting on the strengths and weaknesses of the collaboratively planned lesson. As such, the debriefing component merits special attention from those currently engaged in LS as well as those considering using it [15].

Additionally, LS is a collaborative, teacher-led approach to learning from practice offering a deeper, broader, more sustainable method of improving teacher practice than one-on-one coaching. Teachers and coaches can work together bringing their own professional questions to the work. It accommodates differences in expertise without putting any group member in the role of expert and continues to grow as learners [16].

Materials and Methods

This study involved six teachers that held Science class in a small private basic education institution in Antipolo City, Philippines. These teachers were involved in conducting a LS classes for a period of 9 months. The participation of these teachers commenced with the whole-day training on LS and PP. Specifically, the training focused on the principles and practices of LS, then was advanced with a discussion on the four dimensions of PP – Intellectual Quality, Connectedness, Social Support, and Recognition of Difference. Further, the participants were tasked, during the training, to critically reflect on the extent by which each of the dimensions of PP are usually present in their respective teaching practices. The training ended with a workshop where participants planned a lesson targeting indicators of the dimensions of PP. Lessons were presented, and researchers and teacher participants engaged in a peer critique of the lesson plans. These initial lesson plans formed the basis of the first cycle of the study where the participating teachers modified the plans and implemented them.

The implementation of the LS was divided into six cycles where each cycle takes one month to accomplish. The researcher, together with a knowledgeable other (a colleague from a university) participated in RL observations and post lesson discussion. Specifically, the teacher-participants in each group underwent the following activities in every cycle:

1. RL planning
2. Delivery of the RL
3. Observation of a conduct of the RL
4. Post-lesson discussions

5. Focus group discussion (conducted every after three cycles)

Due to page limitations, this article will report only the first three cycles of LS. The study adopted a main focus that was supposed to be a guide for teachers in their lesson planning and in post classroom discussion. For the first three cycles, the focus was PP framework.

While lesson planning was participated by all teacher-participants, only one teacher was assigned to deliver the RL in one cycle. The rest of the teacher- participants observed the delivery of the lesson. The teacher assigned to deliver the lesson primarily endeavored to implement the RL as planned and agreed by the group. On the other hand, the observing teacher-participants took note of the significant aspects and processes of the lesson. Likewise, the observers took note of the different aspects or processes of the lesson that must be improved. These served as inputs of the observers during the post-lesson discussion.

The post-lesson discussions tendered opportunity for teacher-participants to share significant reflections and insights with regard to the LS implementation. Reflections and insights of the teacher assigned to execute the lesson centered around the difficulty encountered in carrying out the planned lesson. Facilitated by the researcher and the knowledgeable other, the post-lession discussions pointed out significant elements according to the focus of the study that are either exemplified by the current lesson or must be observed in the succeeding lessons. Post-lesson discussions likewise urged the teacher-participants to reflect on their respective (as well as collective) understanding of the focus of the study and perceived capacity to translate this understanding into practice. These reflections were crucial especially in planning for the succeeding RLs. Teacher-participants, researcher, and knowledgeable other also wrote their individual reflections after every lesson study cycle and a focus group discussion was conducted after the first three cycles.

These LS activities returned four main sets of qualitative data as follows:

1. Transcripts of discussions during post-lesson discussion
2. Teachers' individual reflective journal at the conclusion of the lesson
3. Researcher's own feflective journal
4. Knowledgeable other's notes
5. Transcripts of the Focus Group Discussion

All data were video recorded and transcribed. As teachers used bilingual, either their mother tongue and/or English to discuss about their lessons and experiences, sections of transcripts were translated to English for ease of analysis. These qualitative datasets were thematically analyzed to extract indicators of how the LS helped the teacher-participants develop or enhance their understanding and practices of LS and PP. Implications to the principles and practices of LS as a teacher professional development model were also drawn.

Results And Discussions

The teachers demonstrated a significant commitment to the Project and its operation. Attendance was consistently high in all activities. The lessons themselves demonstrated significant amount of preparations on part of the teacher, either as background readings or preparations of audio visual aids. A number of the teachers in their comment during the post-lesson discussions have referred to the training days' sessions indicating a deep engagement with some of the ideas they discussed. In the midterm focus group, they felt that co-teachers observing them during the cycles first felt a bit awkward but later they saw it as an advantage for they seized it as a form of support and help from their co-teachers. They thought of it as a collaborative work among themselves.

Nevertheless, by the middle of the study, it was clear that the teachers were not able to demonstrate their confidence in the use of the PP framework in their lesson plans or discussions. Argua-

bly, it may be the case that the PP framework was too theoretical, complex and comprehensive for teachers to develop a deep understanding of it and its implementation in the short training that they have received. Perhaps further engagement with the framework was necessary to support the LS that the teachers were engaged in.

Cycle 1 – Terrestrial/Land Animals (Grade 4)

The RL was composed of two parts: (1) the introduction, which is customarily the motivation part in the classrooms in the Philippines; (2) the main lesson, which done through group activities, reporting, and whole class discussions.

Several issues emerged in the observation of the first cycle for Science Research Lesson: (1) the importance of having clear objectives; (2) engaging in substantive conversations; and (3) utilizing meaningful tasks/actitivities; and (4) and the need to improve on critical content.

Clarity of Objectives

The teacher started by showing 3 pictures of animals one by one and elicited from students how they would describe each. The first photo was shown: that of a tiger. The students described it as “wild, hairy, which sharp teeth, with tail”. The teacher asked what the sharp teeth is for, and the students said, “for eating”. The teacher further asked what the tiger eats, and the students answered, “meat”. Then the teacher asked where tigers could be found, eliciting “forest” as the response from the students.

[At this point, one could ascertain that the lesson would be about the habitat of the animals. However, discussions on what the tiger eats in connection to the habitat was not processed further.]

The teacher proceeded to showing the next photo, that of a snake. The students described it as “long, silky (madulas), and wild”. One student said it has “no bone”. This notion of snake having no bone was put forward.

Teacher (T): So, according to your classmate, the snake has no bone. Does it have no bone? Who says yes that it doesn’t have bones? Who says it has? Raise your hand. OK I repeat, who says that the snake has bones? Who says it has no bones, raise your hands? …. So, only three students are saying that the snake has bones.

Student (S): It’s a reptile.

T: It’s a reptile. OK. Reptiles are cold-blooded animals.

S: Poisonous.

T: Venomous. What else? If it’s a reptile, if it’s a cold-blooded animal, what does it usually eat?

S: Rats! Meats!

T: Does it eat humans?

S: Cow! Carabao! Humans!

S: Only Anaconda can eat humans!

T: What are you saying?

S: Frog.

T: OK. Frogs. So, depending on the size of the snake… it will eat what smaller [than its size], but if the prey is bigger, its mouth can expand…. What does it do when it eats? Does it chew?

S: No.

T: So, what does it do?

S: …. It would poison [its prey].

The discussion on snake went on to self-defense, its changing of skin, and finally went back to the question on where it is seen – all of these ideas not melded in ways that would give a more holistic characterization of animals’ habitats.

At this point, it became cumbersome to ascertain whether the lesson is indeed about habitats. The points of discussion didn't appear to have a clear direction as it discussed about different ideas such as snakes being poisonous, how it eats, physical structure of the snake – all these ideas not processed in a way that would strengthen the discourse on animals' habitat. Moreover, it seemed that the teacher was not really making sense of the answers of the students. When a student said that it was a reptile, she just asked, "what else?" and proceeded to ask what it eats. If the objectives were clear on the mind of the teacher, she could have led the students into discussions that would have led to the focus of the lesson.

It was very important that the objectives for the lesson was clear on the part of the teacher in order to guide her in leading her questions and framing the discussions.

Substantive Conversations

The introduction of the lesson transpired in such a way that a lot of ideas were being elicited from the students via question-and-answer. This way of classroom discussion presented opportunities for students to express what they currently know and process them into understanding about a new concept – in this case, animals' habitats.

T: You said a while ago that both the tiger and the snake live in the jungle or forest. So, they are live there together?

S: Yes

T: What would happen if they live together [in one place]?

S: The tiger would eat the snake.

T: So, how would the snake survive?

S: They would hide under the ground.

T: They would hide under the ground or on top of the tree… What else?

S: Inside a house.

T: In the forest?

S: Cave

T: OK, so inside the cave. So, usually, the snake is inside the cave, so it would not be easily seen by their predators… or in the rivers.

Nevertheless, it would take some discipline on the part of the teacher to reflect on what information to tell the students and when to expose a particular knowledge. After talking about the snake, the teacher showed a picture of a camel and asked the students to describe it. Students said it's "big, bigger than snake, and it has some humps in its back".

T: What is the humps of the camel for?

S: Water.

T: For water. Why water?

S: It lives in the desert.

T: OK. It lives in the desert. So, it means that water is stored here [in the humps]. So, does it mean it only has little supply of water? So, they need to drink water to survive. They very little supply of water in the desert, so the water is stored in the humps. So, it's being seen in the desert. What does the camel eat?

S: Grass! Potato!

T: OK, grass. Would it eat cactus?

S: Chicken!

T: Does it eat sand? Or is it also carnivorous?

At this juncture, the teacher was already presenting her explanations albeit in a not-so-concise manner. She proceeded to what she also asked for tiger and snake – "what does it eat"? The questioning went on using what seemed to be fragmented concepts – asking about whether camels eat sand, or if it carnivorous, or what would it eat if someone is herding it. Again, no connections among these concepts were explicitly done by the teacher.

Meaningful Tasks/Activities

Going on to the main activity/task for the lesson, the teacher said that they would be talking about terrestrial animals – after asking the students what's common among the tiger, the snake, and the camel. The main activity was devolved amongst the students. They were grouped into 4 and a puzzle was assigned to each group. The students were supposed to solve the puzzle, name the formed figure, provide all possible descriptions of the figure, and present it in class. They were instructed were instructed to do the said activity in 10 minutes. The teacher was keen on how the classroom noise would be managed:

T: OK, we're going to do the activity with not so loud voices. Otherwise, the members from the other groups might hear what you are doing.

S: Yes.

T: The most "quiet" group will have additional points…. Timer starts now…

[After 30 minutes of students doing the task:]

T: Only group 4 is very good because they were quiet. OK, please arrange your chairs. Leaders, please manage your members. Look at the members who are well-behaved. OK, ready? Now, you may go back to your proper places… are you ready to listen?

S: Yes.

…

T: What do we use in listening?

S: Ears.

T: Ok, ears. So, do we need [to use] our mouths?

S: No.

In this part of the lesson, one could ask what would the benefits of working with puzzles be when the intellectual quality of the students are to be enhanced during classroom discussions. During the post-lesson discussions, though the use of puzzles was considered enjoyable by the students, one of the observers said that it took them so much time to complete the task especially in the cutting part. The knowledgeable other also pointed out the it would have been more facilitative if there were more variations in the animals in grouping them into vertebrate or invertebrate. Or, to push it further, the idea about have a huge variety of animals and let the students group them into their own conceptualizations. The students would have to think about the unifying characteristics of the animals and reason out why they had that grouping and give justifications for their choices. In this way, the activity would elicit meanings from the students, and the teacher would lead them to the objective target knowledge afterwards.

The grouping of the students was also commented on by one observer. She said that it was helpful that students were grouped in such a way that capable students were spread out in the groupings. Another observer was happy about one group where each of the members had different roles in completing their tasks.

The researcher suggested looking at the previous classifications tackled prior to this lesson. Did the students already know from their previous lessons or grades about certain classification of animals, such as terrestrial, aquatic, aerial? How would this knowledge be used in this particular lesson?

Nevertheless, the use of x-rays was also commended by the researcher, especially in classifying vertebrates and invertebrates. These visuals made accessible how the notion of having bones or skeleton is related to the notion of being vertebrate or invertebrate.

Furthermore, the knowledgeable other pointed out how the topic could be applied in real-life of the students in order for them to see the importance of why we have to classify. Why is there a need to organize things? She suggested showing two rooms where one is organized and the other one is not. It could lead to the notion of taxonomy. She also talked about integrating the lesson to Christian Values, like how do we take care of animals; or how do we appreciate God's creation?

The question on why students should learn about this topic was actually done in the classroom, but the teacher was not able to create a deeper processing of the students' responses. When a student said something about knowing how to take care of the pets, the teacher could have asked probing questions, such as: "What do you think would happen if you let your pet dog stay in the pool? Will it survive?"; "What would happen if you take the goldfish out of the aquarium?" Since these questions were possibly coming from the students' experiences, it would be nice to draw these ideas out from them.

Critical Content

Certain content areas in the lesson were critical during the discussions. In the introductory part, there was a doubt in terms of the teacher's knowledge about the notion of snakes having bones or not. She was not able to cement whether snakes had bones or not; and appeared to have depended on student's votes (only three of the students raised their hands when asked if snakes have bones).

Same situation was seen in the succeeding discussions in the main tasks when students were asked to categorize given animals as either vertebrate or invertebrate. Vertebrates were defined as animals with backbones, and invertebrates were those without backbones. The teacher asked the students to imagine when the x-ray of the animals were taken.

T: If we're going to describe the physical appearance of the animals… if you're going to x-ray those animals… looking at the inner parts… (showing an x-ray of a horse)… what's this?

S: Horse.

T: OK, can you describe the physical appearance of the horse?

S: Dark. Hairy. Kicking.

T: …. A horse is a mammal. When we say mammal, it does breastfeed… So, just like humans, you were also breastfed [by your mother], right? … So what if we take its x-ray, what do you see in this picture?

S: Bones.

T: Ok, it has bones… how about this one (spider). What's this?

S: Spider. What if we take its x-ray? Will it also have bones like this one (horse)?

S: No…

Several animals were considered for classification as either vertebrate of invertebrate. However, no processing was done in terms of its connection between backbone and bones. For example, as earthworms would easily be considered invertebrate, how about the grasshopper, centipede, and ant? How about the snake?

Nevertheless, the teacher asked the students of the importance of knowing about these classifications.

T: What is the importance of knowing [about] vertebrate and invertebrate animals?

S: So that we know.

T: Why do we have to know?

S: So we would know if [the animal is] wild or not.
T: What about wild animals?
S: Dangerous.
T: Do wild animals or land animals have backbone?
S: Yes.
T: OK, what else?
S: So that we know if [the animal has a] backbone.
T: Why do we need to know if [an animal] has backbone or none?
S: … so we would know when we have invertebrate animals in our homes, we would know how to take care of it because invertebrates might be very delicate.
T: Vertebrate and invertebrate animals in terrestrial place or habitats. So that's all, thank you! Humans belong to vertebrates because they have backbones. So, thank you, Grade 4!

The discussion was going rounds and it seemed that the teacher needed to push the discussions some more. Her knowledge of the issue/topic was definitely called for in the last exchanges in the lesson.

During the post-lesson discussion, the relationships between backbone and "no bones" was raised by the researcher. This critical juncture happened in the introductory discussions and resurfaced again in the processing of the main task. As it appeared in the lesson, the teacher was implicit that the snake has "no bones", but it was pointed out by one of the researchers that snakes, indeed, even have a lot of bones!

The knowledgeable other further probed on the relationship of bones and backbones, and asked about the spider.

R: Isn't it that the spider has bones, but not backbone?
T: They have cartilage, not bones. It's not vertebrate.

This discussion justified the need for deeper knowledge on the relationships and nuances of concepts and terminologies. The question on whether the spider has bones would lead to another related concept, which is skeletons. Spiders, being arthropods, don't have bones, but they have exoskeletons that support their muscles. So, different concepts are coming out here, such as the connection of skeletons with an animal being vertebrate or invertebrate.

Furthermore, the knowledgeable other pointed out the situation in the class when a student asked whether a shark is a vertebrate. The teacher made it clear that the topic was about terrestrial animals. The researcher implicitly suggested that even being an aquatic animal, since the definition of vertebrate vs. invertebrate animals was based on having a backbone or not, it should have been clarified in which category the shark falls.

It was observed that teacher-observers tended to comment about strategies; and the researcher, together with the knowledgeable other, tended to probe further on the content and push for applications and justifications of the decisions made in the lesson. The teacher-observers were encouraged to talk/share more and be "more critical" the next cycle.

Cycle 2 – Renewable and Non-renewable Resources (Grade 3)

The lesson started with some sort of conversations between the teacher and the students using question-and-answer method, with minimal deeper/further probing. The teacher first reviewed on the past lesson on the concept of natural and man-made resources by asking the students some examples of which. She went further by asking the importance of these resources and the differences between the two types of resources.

Two emergent issues were seen in the conduct of the research lesson: (1) cohesiveness and clarity of the objectives; and (2) handling of critical content.

Cohesivenes and Clarity of Objectives

After the introductory/review part, the teacher then showed pictures of "raw materials" and asked the students how each of it works – stove, boat, Shellane.

T: I have here a picture of raw materials and then you are going to say how does it work. What's this?

S: Man-made!

T: Let's consider these one by one. What are these things?

S: Appliances.

T: Appliances. How about this one?

S: Stove.

T: Oh stove. How do the appliances work?

S: Electricity!

T: Electricity. How about the boat?

S: Machine.

T: Machine. How about Shellane?

S: Gas.

T: So what can you say about what's common among these objects or materials? …

S: [The use of] electricity.

T: So most of them are man-made. Does this have a relationship with our past less on natural and man-made resources?

One point to consider here is the teacher's choice of "raw materials" as a terminology that would describe these "appliances". The teacher was also not making deeper sense of students' answers in the exchanges, as if she was waiting for specific answers. However, at this point, it was still difficult to ascertain where these conversations are leading to.

At this point, as the teacher asked for a relationship between the current "lesson" and the past lesson, even if the students said "yes", it was not still clear what the current lesson is all about – which was about renewable and non-renewable resources. This was remarkable as the teacher was actually expecting the students to be able to articulate what the main topic is all about at the end of the lesson, without explicitly saying what it is.

Continuing, the teacher showed more photos. She explicitly stated that the following pictures of natural resources that she would show in order to allow the students to compare it with the first three photos.

T: (Showing a picture of the Sun.)

S: Sun!

T: What energy comes from the Sun?

S: Vitamins.

T: What kind of vitamins?

S: D!

T: Vitamin D or …?

S: C! A!

T: Vitamin D, right, what is vitamin D called?

S: Sunshine!

In this part of the exchanges, another misconception of the teacher on the Sun as the source of vitamin D surfaced. She still did not make deeper sense on the students' response on [the Sun] being also a source of vitamin C! or A!

This level and tone of conversations went on as the teacher proceeded with the lesson. She showed pictures of rain, trees, train, oil.

During the post-lesson discussion, the researcher and the knowledgeable other talked at length regarding the organization of the concepts. There was a confusion in the overlap between the previous lesson on the man-made and natural resources versus the current topic on renewable and non-renewable resources. As the teacher also wanted to elicit from the students what that lesson was about, one point of discussion is on how to decide of what could be discovered by the students, or what could just be provided by the teacher – given the grade level of the students. The questioning of the teacher was also pointed out, some questions seemed to have misled the students, making them more confused. There were also discussions on the teacher's misconceptions that surfaced during the classroom discussions.

Critical Content

The discussions were lively as the teacher was able to elicit answers from the students, albeit being short answers. Many new terminologies came out in the discussions, both coming from the teacher and the students – windmill, charcoal, air, electricity, fish, pearls, motorcycles, gas, fossil fuel. Unfortunately, some terminologies that could be difficult for Grade 3 students were not really discussed further. Some concepts that might be heavy were not processed further. For example, what are fossil fuels? How do charcoals become energy? How is energy transferred? Also, with the objective of teaching renewable and non-renewable resources, the teacher could have zeroed in on the natural resources, or the connections of which on where we source our say, electricity, energy in order to allow man-made resources to function. These connections could have been made clear as the review culminated and the new topic was already being introduced. Nevertheless, there was still no clear direction as to where this lesson was headed to up to that point.

As the teacher was showing photos, she was already grouping these into two (renewable/non-renewable) as she strategically posting them on the blackboard. She directed the students to try thinking about the differences between the two groups of pictures. Then she asked, "What is needed in order for these things (appliances) to function? For example, does the energy coming from the sun limited"?

The students said that the energy coming from the sun is not limited. One student said that the man-made resources may get broken, while the natural resources don't [get broken]. At this point, the students could still not provide the answer that the teacher was expecting – that one group of the pictures would have limited sources to function, thus non-renewable; and the other group would have unlimited sources, thus renewable resources. The teacher capitalized on the notion of "being broken or destroyed" in order to arrive at the objective of the lesson.

T: What do we do if this [stove] gets broken?
S: Replace.
T: So, we can buy again, how about this one (Sun), does this get destroyed?
S: It doesn't get destroyed.
T: So, no, because it's a natural resource. So, what is the difference between these two (referring to the two groups of pictures)?
S: For that group (non-renewable), if it gets broken, it could be replaced.
T: OK, how about this (renewable), does the rain get destroyed?
S: No.
T: How about the plants?
S: Yes!
T: OK. How could plants be replaced?

S: Plant [new ones].

T: It's going to grow. How about the wind?

S: No.

T: So how do we describe these two groups [of pictures]? Some are saying these (referring to one group of pictures) are living things. How about these (the other group).

S: Non-living things.

T: Can you still say some more? Aside from living things and non-living things?

At this point, the classification on renewable and non-renewable resources was still not being perceived by the students. The teacher continued directing the discussions to the notions of reproduction, how the population of humans/animals grow. She also asked whether the Sun grows in terms of number or not, until she went to water and asked whether it would run out. She emphasized the notion of "running out" and asked the class again on how the two groups of pictures could be classified. She further stretched the discussion to the notion of "easily being able to (re)create or (re)produce", connecting it to the notion of the length of time if would take to produce petroleum, coal, or oil. The discussion went on and reverted back to energy. The students were not able to mouth the exact words that the teacher was waiting for. Here, the teacher wanted to elicit the answer from the students.

After some discussion on each of the photos, the teacher zeroed in on the natural resources – sun, water, wind, plant, etc. – and she asked the students what's common among them.

T: … You said that these are natural resources, so, what does it mean?

S: [They] have life.

T: So, if [it has] life, like you (referring to a student), what would happen? How do you stay alive? Yakira said that if there's no air, it would be hard to breathe. What if there's no Sun?

S: Dark.

T: Dark. Can you survive without the Sun? Can you imagine?

S: No.

T: Close your eyes for a while. Then open it. Do you think that when there's no light, what could you do? What would happen to people?

S: [People would] die.

More examples were given and the teacher asked the students what would happened if these things get lost, or how would they be affected in the absence of such.

Further in the lesson, as the different resources (renewable/non-renewable) were already given, the teacher stated that they have different roles. She made an analogy of this with the students and asked them about their roles [as students]. The students were able to answer being good students, but the teacher challenged them to go beyond this and reflect on their roles after knowing about renewable and non-renewable resources. The students' responses referred to how they would take care of the environment – cleaning, taking care [of plants/animals], segregating biodegradable and non-biodegradable materials.

Although the researcher and the knowledgeable other encouraged all the teacher-participants to say something about what transpired during the research lesson, it was still apparent that the post-lesson discussion was dominated by the researcher and the knowledgeable other. The teacher-participants, just like in the first cycle, commented more on the strategies, such as the size and orientation of the visual aids, the grouping of the students, arrangement of visual aids on the board, and the decision on the length of the review. One of the teacher-participants remarked that there were so many concepts tackled in the span of that period. However, one teacher-participant made a sugges-

tion regarding how the teacher could have approached the lesson, given that the previous lesson was about natural and man-made resources.

Teacher: Since there have been landslides in the area very recently, how about asking the students why landslides happen? Why are there flooding? In this way, you didn't have to show the students pictures, you just allow the students to think by themselves. What you did was the other way around, you asked what would be the effect of, [say], throwing garbage….

In this regard, a teacher-participant already went beyond commenting on strategies and visual aids. In this cycle, it could be conjectured that having more exposure to post-lesson discussions might allow teachers to also grow their repertoire in terms of making sense of what they observe in class, how they observe, and what they would comment about. However, the issue of content mastery of teachers and developing intellectual quality of the lessons is still something to be addressed.

Cycle 3 – Weather Conditions (Grade 3)

In this third cycle, as if picking up from the comments for the last lesson raised in the post-lesson discussion – wherein it was suggested that some situations that are proximal or relatable to the experiences of the students may be considered and elicit ideas on why or how it occurred – the teacher started off by showing an image of a car submerged in flood water. The teacher explicitly told the students that the picture shown was from the recent big flooding in Cagayan de Oro City due (only) to low pressure area (LPA) rainfalls.

The teacher briefly discussed about ITCZ (Intertropical Convergence Zone). However, what was lacking was further valuing or processing on why, given that there was no storm, and there was only an LPA, the flooding seemed to have severe effects. Though the teacher said that being in a tropical country, we usually experience heavy rains, there seemed to have little point of comparison whether the one shown in the picture is a usual occurrence in the are or not. There were no opportunity for students to discuss deeper on the possible factors that could have caused that heavy flooding despite not have a stong typhoon.

The teacher showed another picture of a flooded area in Cagayan Valley. He said that picture was taken the previous year during one of the strongest storm signals in the Philippines. It was storm signal number 5, whereas the strongest in the given scale is only up to signal number 4. The teacher asked, what would happen and directly asked what would be damaged given this very strong storm signal.

The students were able to share their ideas, but no connection or comparison was done with this example to the situation in the first photo.

After showing the first two photos, the teacher showed four more – but this time, four different weathers: sunny, windy, rainy, stormy. The teacher asked the students what they could do in the different weathers, and what are the effects of these weather conditions to the daily routine of people – with death as the most severe effect given by the students.

The students were then grouped into four. Each group were instructed to do a roleplay based on the weather condition assigned to them. The instruction was not clear as the students were not really asked to do a roleplay, but a tableau where the chosen leader would describe what was going on in the scenario that they pose out based on the assigned weather assigned.

By the end of the group tasks and presentations of their "roleplay", the teacher asked the students what their topic was for the day.

During the post-lesson discussion, each of the teacher-observers were again asked to speak up and make some comments. As expected, they were keen on the loudness of voice of the teacher, the size/visibility of the visual aids, and they were happy about the roleplay as a strategy. One teacher-participant suggested the use of symbols for the different types of weather. One researcher sup-

ported this notion as this could help the students as they read newspapers. One teacher-participant also said that students could see these symbols in their cellphones, and most of the students do have cellphones.

One teacher-participant said that the "mannequin challenge" was a hype during that time. It was similar to what the students did. The teacher said that aside from letting students draw (which was done in a previous cycle), it would be nice to let them do [this strategy] as it would not take as much time. However, another teacher-participant added that thought the roleplay was good, what the students did was just do how the teacher explained/exemplified how the activity could be done. Then, after the students did their tasks, they were again asked to explain. There was some sort of duplication.

Another teacher-participant commended how the teacher was able to relate his examples to what's really going on in the real lives of the students. Building on this, another teacher-participant related the comments on the last cycle of science research lesson to what she had seen in the current cycle – to problematize the situation and let the students discuss. She further pointed out some nuances on the terminology. Though it was pointed out by the teacher that weather can change from day to day, she raised the possibility that it could be sunny in the morning, then rainy in the afternoon. How could this notion be addressed? Is it still "weather"? One teacher-participant, building up on this idea, also shared that there is also the notion of "climate", which is also different.

In terms of valuing, one teacher participant said that if the teacher has written the responses of the students on the board, they would have the opportunity to see which of the things they do on particular weather could be good or bad.

This time, the teacher-participants already start giving suggestions and giving constructive criticisms on the lesson. This was pointed out by the knowledgeable other. She also pointed out that it would be helpful if the teacher could map what students "need to know" versus what's "good to know", and emphasized the valuing part of the lesson as we look at the "effects" of what human beings do given the different weather... and could we affect climate in the long run. The researcher talked about connections and art of questioning. He further commented on strengthening the discussion on what the effects of the weather are in people's activities versus the effects of people's activities [to climate].

The frequency and how spread the research lessons are from one cycle to another could be considered in ruminating on how teachers develop discourse in classroom instruction. It could be seen in this case that teachers appeared more comfortable in sharing their ideas and they were able to consider different aspects of the lesson and the content.

Focus Group Discussion

The teachers realized that they need to develop higher order thinking among their students and that in the preparation of their lessons, they made it a target. They really wanted to use a pedagogy that will achieve students' deeper understanding of the lesson or we call it intellectual quality. In achieving intellectual quality in the classrooms, teachers said that it was easy when they were planning and preparing for the lessons but somewhat a bit challenging when you implement it inside the classrooms. There were several factors that affect the implementation and one of them is teachers' expectation of the answers or responses from the students. Teachers realized that students appreciate when they have an exchange of opinions or debate related to the lesson.

Conclusions

The narratives of the lessons and the discussion above show that teachers have gained some knowledge about their teaching and about their students. For example, there may have been a diver-

sification of methods of teaching and a slight increase in open ended questions. Also some teachers gained confidence in giving feedback on students' misconceptions and mistakes. However, there remain concerns about some of the issues in need for further work:

1. A focus on deep and functional content knowledge of teachers. In particular care should be given to focus, cohesiveness, and clarity of objectives; exactness of definitions and their meaning; connection between the concepts; and deep structures of the discipline.
2. A focus on a better connection between the different components of lessons. In particular, a focus the sequence of activities and connection between them, and a focus on relating the introductory activity to the main idea of the lesson.
3. A focus on questioning techniques. In particular avoidance to too many low order thinking and close ended questions – and allowing students to talk at length about their knowledge and question each other's views.
4. A focus on a variety of teaching methods that allow for greater student engagement at a higher level of thinking.

The evidence from almost all lessons discussed above reveal that there are some problems with teacher's knowledge of the content being discussed in class. There were some, either shallow knowledge or, in many cases, non-standard interpretation of concepts under consideration by most teachers. At times, the source of the errors came from the textbook itself. What is of interest, is that the post lesson discussions addressed these mistakes only when they were raised by the researcher and the knowledegeable other, and almost never by the other teacher-observers.

ACKNOWLEDGEMENT

I am very grateful to Private Education Assistance Committee (PEAC) for funding this study; to De La Salle University for housing this research; and to teachers and students of School of Everlasting Pearl, Inc.

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