LOOK ACADEMIC PUBLISHERS
OPEN ACCESS

INTERNATIONAL JOURNAL OF ENVIRONMENTAL & SCIENCE EDUCATION
e-ISSN: 1306-3065
2018, Vol. 13, No. 10, 817-830

Teaching Disaster Readiness and Risk Reduction (DRRR) in Senior High School using Metacognitively-Oriented Science Classroom Learning Environments (MOSCLEs)

Heidi F. Abelita [1], Michael A. Clores [2*]

[1] *San Pascual National High School, San Pascual, Masbate, PHILIPPINES*
[2] *Ateneo de Naga University, Naga City, PHILIPPINES*

* CORRESPONDENCE: mclores@gbox.adnu.edu.ph

ABSTRACT

The Philippine's Department of Education's goal of ensuring that learners understand disasters and helping them become more vigilant within every home and community so that lives are saved is institutionalized more specifically in the implementation of the K to 12 curriculum of Senior High School (SHS) Core Subject on Disaster Readiness and Risk Reduction (DRRR). This study explored the use of an innovative teaching approach, Metacognitively-Oriented Science Classroom Learning Environments (MOSCLEs), in teaching DRRR in SHS. The mixed method, expansion design was utilized in this study to widen the breadth of understanding of MOSCLEs. The quasi-experimental post-test only design was applied in the quantitative part to determine the significant difference in the students' level of conceptual understanding of hydrometeorological hazards in MOSCLEs and traditional classroom instruction. For the qualitative study, grounded theory approach was done to explore on the students' own reflections while learning and the teacher's reflections while teaching the said subject matter. Results showed that students taught using MOSCLEs gained higher mean score than the students taught using the traditional method, implying that the use of metacognitive strategies enhances concept attainment of the content. Two themes emerged from the template analysis of the student's reflections: *"Students' metacognitive abilities and skills"* and *"Teacher's deliberate actions to develop students' metacognitive abilities and skills."* These themes imply the development of learners' metacognitive potentials relies on the teacher's pedagogical process. From the teacher's reflections, two themes emerged, *"What metacognition is"* and *"Design of a metacognitively-oriented pedagogy,"* which imply that developing the learners' metacognitive skills requires the processes of planning, monitoring, evaluating and reconstruction of existing ideas. Through MOSCLEs, students learned better and the teacher became more aware of her own teaching process along with the students' learning process.

Keywords: Disaster Readiness and Risk Reduction (DRRR), metacognitively-oriented science classroom learning environments, metacognition, senior high school, mixed method

INTRODUCTION

The Philippines is one of the countries that is highly vulnerable to disasters due to its geographical conditions. According to the World Risk Report on 2016, it ranks third out of 171 disaster prone countries (Welle & Birkmann, 2016). For their part, the Department of Education enjoined its workforce to help in increasing the capacity of the learners, schools and communities in ensuring safety, reduced exposure to

Article History: Received 28 June 2018 ◆ Revised 12 November 2018 ◆ Accepted 24 November 2018

hazards, and decrease vulnerability to disasters. This is institutionalized more specifically in the implementation of the K to 12 Curriculum of Senior High School Core Subject on Disaster Readiness and Risk Reduction.

The contemporary science education is directed towards preparing the learners for successful partaking and commitment in whatever lay ahead. One of the crucial concerns for the learner's development involves self-regulation and metacognition. As espoused by Flavell (1971), and used concretely by Thomas (2012), an individual's metacognitive knowledge regarding their learning performance in science subjects would include knowledge of his/her strengths, weaknesses, and learning processes, together with an awareness of his/her repertoire of tactics and strategies and how and under what circumstances these could enhance or inhibit learning and/or cognitive performance. It was revealed that metacognitive practices have positive effect on students' academic achievement (Georghiades, 2000; Young & Fry, 2008; Dignath and Buttner, 2008; Chauhan and Singh, 2014; Callan et al. 2016; Chiu and Kuo, 2009). Also, teacher modeling of cognitive strategies and science learning processes is also important for effective transfer of learning (Thomas, 2012).

To explore the effectiveness of metacognitively-rich environment, this study was done to explore the implementation of a teaching approach, Metacognitively-Oriented Science Classroom Learning Environments (MOSCLEs), in learning Disaster Readiness and Risk Reduction (DRRR) among senior high school students. Specifically, this study aimed to determine if there will be a significant difference in the level of conceptual understanding of the students about Hydro-Meteorological Hazards (H-MH) after being taught in MOSCLEs compared to those who were taught using the traditional classroom instruction. It also examined the students' reflections while learning and their teacher's reflections while teaching H-MH in MOSCLEs.

The study is anchored on the dimension of the Metacognition Theory of Flavell and dimensions of Metacognitively-Oriented Science Classroom Learning Environments (MOSCLEs) proposed by Thomas (2012). These dimensions include the following: Student-Student Discourse, Metacognitive Demands, Student-Teacher Discourse, Student Voice, Distributed Control Teacher Encouragement and Support, and Emotional Support. It is argued in the present study that for knowledge acquisition or concept attainment to occur in science classrooms, teachers should facilitate the use metacognitive activities to learn science and to be aware of how these activities help them to learn science. In MOSCLEs, the teacher behaviors are assumed to make science classrooms particularly metacognitively oriented.

METHODS

The mixed method, expansion design was utilized in this study. Quasi-experimental post-test only design was applied to answer the first three questions of the study and grounded theory approach was done respectively to explore the students' own reflections while learning and the teacher's reflections while facilitating the lesson. This was conducted in San Pascual National High School, San Pascual, Masbate, particularly in the Grade 12 Senior High School students. There are four heterogeneous sections of Grade 12 classes under General Academic Strand (GAS). All were the participants of the study. Assignment as experimental or control groups was done randomly to the four sections. Two classes were randomly assigned as control groups taught using traditional method and two classes as experimental groups taught using MOSCLEs.

MOSCLEs-based lesson plans and traditional learning environment lesson plans were designed (See Appendix A for some of the activities incorporated in the MOSCLEs lessons). Two-tiered conceptual understanding test as post-test, and reflection guides for the students and teacher were developed and validated for the conduct of the study. Post-test scores of all the samples from the two groups were analyzed using inferential statistics to determine the significant difference between the post-test scores of the students. Levene's Test for Equality of Variances and t-test for Equality of Means were used to compare results of the post-test of the four groups. For the qualitative study, purposive sampling of students' reflection was done. To elicit the reflections of the students while learning and of the teacher while teaching, a reflection guide was given to students after every session. The guide contains prompts to explore relevant insights. The reflections were analyzed using Strauss and Corbin's grounded theory method of analyzing qualitative data (Polit and Beck, 2009). To facilitate the analysis, the data management software, NVivo Pro 11 (www.qsrinternational.com/nvivo/nvivo-products) was used. The software aided the researcher in organizing, analyzing and finding insights from the reflections of the students and teacher.

RESULTS

Level of Students' Conceptual Understanding of Hydrometeorological Hazards after Instruction using MOSCLEs Traditional Instruction Method

The mean scores of students taught using MOSCLEs (M±SEM=8.87±.443, SD=3.63) was significantly higher than the mean scores of the students using the Traditional Instruction (M±SEM=5.86±.341, SD=2.73), t(129) = 5.35, p= .000) (**Table 1**).

Table 1. Post-test scores of the students on the conceptual understanding test on hydrometeorological hazards taught in Metacognitively-Oriented Science Classroom Learning Environments (MOSCLEs) versus Traditional Method, 2017

Section	N	Mean Score ± S.E.M.	SD
MOSCLEs	67	8.87±.443	3.626
Traditional Instruction	64	5.86±.341	2.725

Note: *t*(129) = 5.35, p= .000)

Reflections of Students and Teacher while Learning and Teaching about Hydrometeorological Hazards (HMH) in MOSCLEs

NVivo QSR analysis of reflections of students showed a total of 19 nodes (or codes or theme used during the interpretation) and 80 sources (or the specific student's reflection paper) and 114 references (or the specific entries of the students in the reflection papers). The dominant node was "knowledge of his or her strengths, weaknesses, and learning processes" with 9 sources and 15 references. For the reflections of the teacher, a total of 10 nodes and 16 sources and 27 references in the NVivo QSR analysis were recorded. The dominant node was "student-student discourse - students discuss their science learning processes with each other" with 2 sources and 6 references (See Appendix B for the nodes and their sources and references in the NVivo QSR analysis of students' reflections)**.**

Grounded theory approach of analysis revealed two significant themes from the student's reflections while learning in MOSCLEs: *"Students' metacognitive abilities and skills"* and *"Teacher's deliberate actions to develop students' metacognitive abilities and skills"*. From the teacher's reflection, two themes were derived, "What metacognition is" and "Design of a metacognitively-oriented pedagogy" (See Appendix C for sample quotes from the journals of the students their teacher and their implied subthemes for the identified themes)**.**

In the students' reflection, the significant subthemes in the category *"Students' metacognitive abilities and skills"* are the student's ability to be foresighted, conscious, plan, monitor and evaluate cognitive processes, make self-corrections, awareness of his/her repertoire of tactics and strategies, awareness of how and under what circumstances learning tactics could enhance or inhibit learning and cognitive, and the knowledge of his or her strengths, weaknesses, and learning processes. This implies that students taught using MOSCLEs were able to develop metacognitive skills through the different metacognitive activities employed by the teacher in the pedagogical process which was further justified by the teacher's deliberate actions to develop students' metacognitive abilities and skills. Different subthemes derived from the students' reflection asserted this phenomenon. For example, *"Students' metacognitive abilities and skills"* were developed through the different metacognitive activities given during the lesson on Hydrometeorological Hazards. Through writing of their reflections, the learners were able to be foresighted in their learning process. One of the learners wrote:

> *"…To understand the lesson, next time, I will try to search some additional information so that I have a lot of knowledge about our lesson."*

Another aspect of metacognition cultivated among the student is monitoring cognitive process which facilitates the learners to comprehend better the learning content. Stated in a student's reflection regarding this was:

> *"…One thing my teacher did for this lesson that I liked best was when I'm doing the activity by answering a question 3 Things I learn, 2 Interesting facts and 1 Question I still have, this type of question it can measurable to my mind if I have learned in the past lesson we discussed."*

On the other hand, the theme**,** *"Teacher's deliberate actions to develop students' metacognitive abilities and skills"***,** includes the subthemes: intentional, purposeful, memory skills, summarizing, providing routine activities, emotional support, student-teacher discourse, connecting new from old knowledge, student-student discourse and teacher modelling. The results support Chiu and Kuo (2009), and Thomas and Anderson's (2014) that providing metacognitive lessons can help students develop metacognitive skills. Indeed, metacognitive thinking plays positive role in children's use of knowledge in understanding science education and that teachers should take a lead role in constructing learning environments that are metacognitively oriented (Thomas, 2012).

Developing metacognitive abilities and skills of the students is one of challenges faced by the researcher during the process. Providing metacognitive environment through metacognitive strategies was done to assist in the students' learning process. The teacher must carefully choose activities that the learner would be able to realize the value of their learning. One student's reflection stated that**,**

> *"…One thing my teacher did for this lesson that I liked best was when she gave us an activity and that is the "3-2-1" activity that make me think and the My Future Learning Plans. The "3-2-1" activity has a different question that can measure my knowledge and learning in the Hydrometeorological Hazard activities."*

For the two themes derived from the teacher's reflections while teaching HMS in MOSCLEs, the subthemes in the category *"What metacognition is"* are the following: metacognition is planning cognitive processes, metacognition is monitoring cognitive processes, metacognition is evaluating cognitive processes and metacognition entails evaluation and reconstruction of existing ideas. Analysis showed that metacognition was viewed by the researcher as planning, monitoring, and evaluating cognitive processes as well as reconstruction of new ideas. These metacognitive practices were performed during the teaching-learning process of Hydrometeorological Hazards. Planning cognitive processes guided the teacher in choosing activities that were efficiently and effectively facilitated. Tasks assigned to the students were facilitated easily through the aspect of monitoring cognitive processes. It allows awareness of what is to be done and what is expected of them as individual learners. In one of her reflections, ***s***he wrote:

> *"…I encouraged learner autonomy and metacognitive skills to my students through asking them to think about their experiences and/or observations and then apply it to their group task."*

The theme, *"Design of a metacognitively-oriented pedagogy",* has the subthemes which include: the metacognitive demands (students are asked by the teacher to be aware of how they learn and how they can improve their science learning.), student-teacher discourse (the students discuss their science learning process with their teacher), student voice (the students feel it is legitimate to question the teacher's pedagogical plans and methods), the student-student discourse (the students discuss their science learning process with each other), and the teacher encouragement and support (the students were encouraged by the teacher to improve their science learning processes). The results support the concept of Thomas (2003, 2004) which is the existence of dimensions that can be used to ascertain the extent to which science classroom learning environments are metacognitively oriented. Thomas established that in Metacognitively-Oriented Science Classroom Learning Environments (MOSCLEs), teachers ask students to be aware of how they learn and how they can improve their science learning, discuss students' science learning processes with them, and encourage students to improve their science learning processes.

In the conduct of the study, overriding dimensions of MOSCLEs were identified in the pedagogical process. The metacognitive demands enabled the learners to be aware of how they learn and how they can improve their learning. The teacher provided activities like "Think-pair-share" wherein students talked about how they learn best in science. Another dimension is the student-teacher discourse. It allowed students to talk about their learning tasks explicitly to their teacher. It offered room for questions, clarifications and other concern about learning. This process imparted both academic and personal experiences in the pedagogical process. The teacher reflects that,

> *"...The strategies and tools I use to promote metacognition to my learners are thinking about their best learning strategy in science and relating the concepts/subject content to their lives."*

Student voice (the students feel it is legitimate to question the teacher's pedagogical plans and methods) was encouraged by the teacher during the process. One of the activities designed for this was the "Act it out" or the role-playing activity. Each group of the students was given specific ***scenario;*** however, they were given the chance to question about the task and they could suggest ideas based on their prior experiences. Allowing students to discuss their science learning processes with each other (student-student discourse) also helped to improve their learning performances. Students were able to learn from each other's sharing of ideas and experiences. Moreover, the '*teacher encouragement and support*' ***are*** one of the dimensions in MOSCLEs that made the learning of the student's more meaningful. In a metacognitive environment, pedagogy should provide constructive advice. As quoted in one of the teacher's reflections,

> *"I pay a lot of attention to the things that I think may affect the student's feelings during the evaluation and giving of feedback to their presentations"; "…providing encouragement to improve their learning process."*

DISCUSSION

This study explored the effectiveness of Metacognitively-Oriented Science Classroom Learning Environments (MOSCLEs) in teaching Disaster Readiness and Risk Reduction among senior high school students. Results showed that after instruction, the overall mean score showed that MOSCLEs (Mean Score ± S.E.M. = 8.87±.443) was more effective as teaching model than the traditional classroom instruction (Mean Score ± S.E.M. = 5.86±.341) in promoting conceptual understanding. These results confirmed what Chiu and Kuo (2009) stated that students learn metacognitive skills by creating supportive learning environments or through metacognitive lessons. Reflection on the psychosocial dimensions is necessary to students' learning. Providing metacognitive experience could also lead to a metacognitive change in some students (Thomas and Anderson's, 2014). Metacognitive strategies play a positive role in learner's achievement in science education (Callan, et al., 2016 and Georghiades, 2006).

Use of metacognitive strategies was proven to improve students' learning. Majority of the students learned Hydrometeorological Hazards effectively because of the utilization of metacognitive thinking. Students were able to gain knowledge about the learning content by thinking about what they have to learn, discuss their learning process with each other and with their teacher, realize how they learn, and improve their learning process. In MOSCLEs class, students were given these learning experiences and were able to attain the learning competencies expected of them. On the other hand, majority of the students taught under the traditional method also acquired the expected learning competencies. It means that traditional method is also effective in the teaching Hydrometeorological Hazards. However, in this pedagogical process, the students were not given an environment to utilize metacognitive thinking.

The results also affirm that metacognition basically helps in students' strategies to effectively learn, plan, monitor and evaluate cognitive processes (Chauhan and Singh, 2014). Metacognitive thinking process has been shown to improve academic attainment in all learning domains (Zull, 2011; Georghiades, 2000; Gunstone, 1991; Adey & Shayer, 1994 Wang, Haertel, & Walberg, 1990; Young & Fry, 2008; Ormrod, 2011; Chauhan and Singh, 2014; Dignath and Büttner, 2008; Callan, et al. 2016; Baker & Brown, 1984). It is also a key element of science learning and that developing students' metacognition can enhance their science learning (e.g., Donovan and Bransford, 2005; Georghiades, 2004; White, 1998; White and Frederiksen, 1998; White and Mitchell, 1994).

The difference on the mean score of students under MOSCLEs and traditional method indicates that the use of metacognitive skills plays a significant part in the teaching-learning process. Creating a metacognitively-oriented science learning environment provided room to improve students thinking skills into a higher level which is metacognition. Metacognitive practices are passed on to the students from the teacher modelling and provision of metacognitive activities. Traditional classroom practices may give comfort to the pedagogical process but taking the challenge to improve it using contemporary teaching approach such as metacognitive strategies will contribute much to the development of students' academic competence.

Two themes from the student's reflections while learning in MOSCLEs: *"Students' metacognitive abilities and skills"* and *"Teacher's deliberate actions to develop students' metacognitive abilities and skills."* The subthemes in the category *"Students' metacognitive abilities and skills"* are the student's ability to be foresighted, conscious, plan, monitor and evaluate cognitive processes, make self-corrections, awareness of his/her repertoire of tactics and strategies, awareness of how and under what circumstances learning tactics could enhance or inhibit learning and cognitive, and the knowledge of his or her strengths, weaknesses, and learning processes. This implies that students taught using MOSCLEs were able to develop metacognitive skills through the different metacognitive activities employed by the teacher in the pedagogical process which was further justified by the teacher's deliberate actions to develop students' metacognitive abilities and skills. Different subthemes derived from the students' reflection asserted this phenomenon.

These findings support Flavell's (1971) notion that metacognition is intentional, conscious, foresighted, purposeful, and directed at achieving a goal or outcome and Callan, et al.'s (2016) viewpoint in their study that metacognitive strategies are all about the learner's "thinking about thinking," it includes remembering, understanding, and summarizing. On the other hand, learning strategies were all about memorization and explanation. Learning strategies are basic to metacognitive strategies. It is necessary to utilize basic knowledge for higher order thinking skills. Also, it supports the premise that metacognition allows a learner to be aware of his/her learning performance in science subjects, including his knowledge of his/her strengths, weaknesses, and learning processes, together with an awareness of his/her repertoire of tactics and strategies and how and under what circumstances these could enhance or inhibit learning and/or cognitive performance (Thomas 2012).

In this study, *"Students' metacognitive skills and strategies"* were developed through the different metacognitive activities given during the lesson on Hydrometeorological Hazards. Through writing of their reflections, the learners were able to be foresighted in their learning process. One of the learners wrote:

> *"…To understand the lesson, next time, I will try to search some additional information so that I have a lot of knowledge about our lesson."*

Foresightedness will help each learner to have a goal or vision to achieve in order for him/her to maximize learning. Being conscious or aware about one's learning experience, helps motivate the learners. One reflection says:

> *"… The difficulties I encountered in the lesson are: this lesson is not as exciting as it seems, but I want to know these because it can help me and my family."*

Metacognitive strategies are helpful in letting the learners realize the importance of the lesson taught. Planning cognitive process is one aspect of metacognition which also helps the learner become a goal-oriented individual. Sample quote from the learners' reflection states that,

> *"…In order to understand the lesson, next time I will try to do an advance reading so that I learn better."*

Another aspect of metacognition cultivated in this study is monitoring cognitive process which facilitate the learners to comprehend better the learning content. Stated in the student's reflection regarding this is that,

> *"…One thing my teacher did for this lesson that I liked best was when I'm doing the activity by answering a question 3 Things I learn, 2 Interesting facts and 1 Question I still have, this type of question it can measurable to my mind if I have learned in the past lesson we discuss."*

The use of metacognitive strategies enhanced the learner's ability to make self-corrections. One of the students' reflection stated that,

> *"…To understand the lesson, next time, I will try to take down notes and study hard for effective learning to happen."*

Evaluating cognitive process allows each learner to determine his/her limitations and accomplishments. Knowing one's strengths and weaknesses contributes to maximum learning experience. It enables the learner to determine what tactics or strategies can enhance or inhibit his/her learning process. Some of the students stated that,

> *"... I realize that it is so effective if we used our knowledge in real situations."*

These metacognitive skills and strategies helped the students become aware of their own learning performance.

On the other hand, the theme "*Teacher's deliberate actions to develop students' metacognitive abilities and skills"* includes the subthemes: intentional, purposeful, memory skills, summarizing, providing routine activities, emotional support, student-teacher discourse, connecting new from old knowledge, student-student discourse and teacher modelling. It upholds the research of Chiu and Kuo (2009), and Thomas and Anderson's (2014) that providing metacognitive lessons can help students develop metacognitive skills. It also proves

Georghiades (2006) discovery on the use of metacognitive activities in the learning of science that providing routine activities is effective to students' learning and has positive effect on metacognitive thinking. Metacognitive thinking plays positive role in children's use of knowledge in understanding science education and that teachers should take a lead role in constructing learning environments that are metacognitively oriented (Thomas, 2012).

Developing metacognitive abilities and skills of the students is one of challenges faced by the researcher during the process. Providing metacognitive environment through metacognitive strategies was done to assist in the students' learning process. Teacher's deliberate actions were identified as intentional and purposeful. The teacher has to carefully choose activities that the learner would be able to realize the value of their learning. Students' quote stated that,

> *"…One thing my teacher did for this lesson that I liked best was when she gave us an activity and that is the "3-2-1" activity that make me think and the My Future Learning Plans. The "3-2-1" activity has a different question that can measure my knowledge and learning in the Hydrometeorological Hazard activities."*

The need to use memory skills is basic in enhancing cognitive abilities. Providing routine activities as well as summarizing the lesson was also carried out to develop metacognitive skills. One of the students quoted:

> *"…One thing my teacher did for this lesson that I liked best was she gave examples and synthesize the topic carefully."*

To ensure metacognitive learning environment, the teacher encouraged the students' discussion of the learning process with each other and with the teacher. These actions provided room to bring out ideas from the student and clarify if there are any misconceptions about Hydrometeorological Hazards. Connecting the lesson from old knowledge such as the students' experiences gave chances to them to participate well in the activities. Student quoted:

> *"…One thing my teacher did for this lesson that I liked best was an activity that required our prior knowledge regarding our topic."*

Providing emotional support and teacher modelling played a role in this context. The teacher should demonstrate well how to utilize metacognition to make the most of the learning experience.

Two themes were derived from the teacher's reflections while teaching Hydrometeorological Hazards in MOSCLEs: *"What metacognition is"* and *"Design of a metacognitively-oriented pedagogy"*. The subthemes in the category *"What metacognition is"* are the following: metacognition is planning cognitive processes, metacognition is monitoring cognitive processes, metacognition is evaluating cognitive processes and metacognition entails evaluation and reconstruction of existing ideas. It signifies that the concept of metacognition, its application to the learning process, was executed in the study. Teacher's reflection notes assert the fact that the use of metacognitive processes helped in facilitating effectively science lesson. Creating a metacognitive environment supports the learning process. It supports the principle that metacognition basically helps students in connecting new from old knowledge, strategies to effectively learn, planning, monitoring and evaluating cognitive processes (Chauhan and Singh, 2014). As Borokowski et al., (1987) defined metacognition as an individual's knowledge, and conscious (control and awareness, which implies monitoring, of their thinking and learning processes. It involves students' ability to examine what they are thinking about, to make distinctions and comparisons, to see errors in what they are thinking about and how they are thinking about it, and to make self-corrections (Ornstein and Lasley, 2000). It further affirms the Gunstone's view that knowledge, awareness, control, recognition, and evaluation are in part characteristics of metacognition.

Metacognition was viewed by the researcher as planning, monitoring, and evaluating cognitive processes as well as reconstruction of new ideas. These metacognitive practices were performed during the teaching-learning process of Hydrometeorological Hazards. Planning cognitive processes guided the teacher in choosing activities that were efficiently and effectively facilitated. It assisted the teacher to be well oriented with the learning tasks that will be given to the students. Tasks assigned to the students were facilitated easily through the aspect of monitoring cognitive processes. It allows awareness of what is to be done and what is expected of them as individual learners. As the quote illustrates,

> *"…I encouraged learner autonomy and metacognitive skills to my students through asking them to think about their experiences and/or observations and then apply it to their group task."*

Evaluating cognitive processes is also identified as one of the aspects in metacognition. During the teaching-learning experience, students could create standards for evaluation like rubrics and then the teacher let them evaluate their performances. In this manner they were made aware of how they have met the learning objectives. Through the evaluative process, reconstruction of new ideas was developed. As the quote indicates,

> *"…giving guide questions to the students to think about the previous activity; understanding the importance of hazard maps; and evaluating their own output based on the rubrics."*

These aspects about "what is metacognition?" were formulated based on the teacher's reflection notes.

The theme "*Design of a metacognitively-oriented pedagogy"* has the subthemes which include: the metacognitive demands (students are asked by the teacher to be aware of how they learn and how they can improve their science learning.), student-teacher discourse (the students discuss their science learning process with their teacher), student voice (the students feel it is legitimate to question the teacher's pedagogical plans and methods), the student-student discourse (the students discuss their science learning process with each other), and the teacher encouragement and support (the students were encouraged by the teacher to improve their science learning processes). It supports the concept of Thomas (2003, 2004) which is the existence of dimensions that can be used to ascertain the extent to which science classroom learning environments are metacognitively oriented. Thomas established that in Metacognitively-Oriented Science Classroom Learning Environments (MOSCLEs), teachers ask students to be aware of how they learn and how they can improve their science learning, discuss students' science learning processes with them, and encourage students to improve their science learning processes.

In the conduct of the study, overriding dimensions of MOSCLEs were identified in the pedagogical process. The metacognitive demands enabled the learners to be aware of how they learn and how they can improve their learning. The teacher provided activities like "Think-pair-share" wherein students talked about how they learn best in science. Another dimension is the student-teacher discourse. It allowed students to talk about their learning tasks explicitly to their teacher. It offered room for questions, clarifications and other concern about learning. This process imparted both academic and personal experiences in the pedagogical process. As the quote indicated,

> *"... The strategies and tools I use to promote metacognition to my learners are thinking about their best learning strategy in science and relating the concepts/subject content to their lives."*

Student voice (the students feel it is legitimate to question the teacher's pedagogical plans and methods) was encouraged by the teacher during the process. One of the activities was the "Act it out" or the role-playing activity. Each group of the students was given specific scenario; however, they were given the chance to question about the task and they could suggest ideas based on their prior experiences. Allowing students to discuss their science learning processes with each other (student-student discourse) helped to improve their learning performances. Students were able to learn from each other's sharing of ideas and experiences. They were able to understand the learning content more through the shared previous knowledge about the content. The teacher encouragement and support is one of the dimensions in MOSCLEs that made the learning of the student's more meaningful. In a metacognitive environment, pedagogy should not end up in the evaluation process. The teacher serves a significant role in encouraging the students to improve their science learning processes. Students should realize the importance of improving their science learning. Providing constructive advice must also be considered in this perspective. As quoted in the teacher's reflection,

> *"I pay a lot of attention to the things that I think may affect the student's feelings during the evaluation and giving of feedback to their presentations" and*

> *"…providing encouragement to improve their learning process."*

As the teacher wrote her reflections, insights on how the delivery of the lesson was developed. In this study, only five out of seven dimensions of MOSCLEs came out based on the teacher's reflection notes. It implies that these dimensions: metacognitive demands, student-teacher discourse, student voice, student-student discourse, and teacher encouragement and support were carried out in the teaching process. These dimensions turned out to dominate on the teacher's pedagogical process. However, it does not necessarily mean that the two dimensions, distributed control and emotional support, were not incorporated in the process because activities to address the two dimensions were indicated in the lesson plan of the content and carried out in the teaching-learning process.

Aspects regarding the other two dimensions were not highlighted on the teacher's reflection notes instead they were obtained from the students' reflections. Distributed control which was employed in the lesson through an activity entitled: "My Future Learning Plan" was derived from students' reflections in the subtheme Intentional under the theme Teacher's deliberate actions to develop students' metacognitive abilities and skills. On the other hand, emotional support was integrated in the lesson through an activity "Life Connections through Collage-Making" wherein processing of the sharing of students' life experiences were done. Emotional support was provided in relation to their science learning experiences. This dimension came out also as one of the subthemes under Teacher's deliberate actions to develop students' metacognitive abilities and skills. Reflection quotes implied that the students appreciated the support given by the teacher during their learning process.

This study concludes that the use of Metacognitively-Oriented Science Classroom Learning Environments (MOSCLEs) enhanced the students' conceptual understanding of hydrometeorological hazards through the different metacognitive activities employed by the teacher. Metacognitive skills were acquired by the students through the processing of their own thinking process. The use of MOSCLEs enabled the learners to be aware of his/her own learning performance, specifically the factors that enhanced their conceptual understanding of the content. Reflection of the students justifies this phenomenon and the teacher's reflection notes assert the fact that the use of metacognitive processes specifically the incorporation of the different dimensions of MOSCLEs helped in the understanding of the concept.

Themes derived from students' reflection denote that their metacognitive abilities and skills were developed through MOSCLEs. Attainment of conceptual understanding of hydrometeorological hazards was enhanced by employing metacognitive activities in the lesson. Teacher's deliberate actions to enrich the learners' metacognitive potentials were made through the utilization of the MOSCLEs dimensions. Therefore, the development of learners' metacognitive abilities and skills rely on the teacher's pedagogical undertakings.

This study supports the idea of Thomas (2012) who advocates the use of MOSCLEs' dimensions in the teaching-learning process. Implementation of MOSCLEs requires the students to be aware of their own learning process. This was done through allowing the learners to speak out their previous, present and future insights and discuss it with each other as well as with their teacher. In this manner they became aware of their own thinking. Listening and constructive feedback are the ways done to provide support in them. This is also one of the factors that enhanced their metacognitive potentials.

Further conceptualization of metacognition was developed based on the teacher's reflection notes. As MOSCLEs was implemented, insights regarding this concept were expounded. As inferred from the quotes, metacognition is a planning, monitoring, evaluating and reconstruction of existing ideas. These are the basic framework in developing the learners' autonomy or self-regulation skills. As the students and teacher collaborate for effective learning to happen, both must plan, monitor, and evaluate constantly the process of learning and so there is a continuous reconstruction of ideas.

Metacognitively-Oriented Science Classroom Learning Environments (MOSCLEs), as one of the contemporary innovative teaching approaches used in this study, utilizes self-awareness, constant planning, monitoring, and evaluation of the learning process, and reconstruction of ideas. Provision of metacognitive activities facilitates the students' thinking process and concept attainment of the subject content. It also helps in the improvement of the teacher's pedagogical process. Using metacognition enabled the teacher to understand thoroughly her own teaching process along with the students' learning process.

Disclosure statement

In this study, students were informed about the nature of the study, its benefits and the possible risks. They were also given opportunity to ask questions. Results of the test were subjected to rechecking by other science teacher, but students' scores were treated as confidential. After the post-test, those students who were not exposed to MOSCLEs instruction were also given the chance to experience the activities done by the MOSCLEs class. Reflections of the students and the teacher were also kept confidential.

Notes on contributors

Heidi F. Abelita – San Pascual National High School, San Pascual, Masbate, Philippines.

Michael A. Clores – Ateneo de Naga University, Naga City, Philippines.

REFERENCES

Alcayna, T., Bollettino, V., Dy, P., & Vinck, P. (2016). Resilience and Disaster Trends in the Philippines: Opportunities for National and Local Capacity Building. *PLOS Currents Disasters*, 2016 Sep 14. Edition 1. https://doi.org/10.1371/currents.dis.4a0bc960866e53bd6357ac1357d740846

Callan, G. L., Marchant, G. J., Finch, W. H., & German, R. L. (2016). Metacognition, Strategies, Achievement, and Demographics: Relationships Across Countries. *Educational Sciences: Theory & Practice*, p. 1485 - 1502.

Chauhan, A., & Singh, N. (2014). Metacognition: A Conceptual Framework. *International Journal of Education and Psychological Research (IJEPR), 3,* Issue 3.

Chiu, M. M., & Kuo, S. W. (2009). Social metacognition in groups: benefits, difficulties, learning, and teaching. Metacognition: *New Research Developments*, p. 1.

Dignath, C., & Buttner, G. (2008). Components of fostering self-regulated learning among students. A meta-analysis on intervention studies at primary and secondary school level. *Metacognition and Learning, 3,* 231–264. https://doi.org/10.1007/s11409-008-9029-x

Fernandez, G., & Shaw, R. (2014). Youth participation in disaster risk reduction through science clubs in the Philippines. *Disasters, 39*(2), 279–294. https://doi.org/10.1111/disa.12100

Flavell, J. H. (1971).First Discussant's Comments: What Is Memory Development, *The Development of Human Development, 14,* 272-278. https://doi.org/10.1159/000271221

Georghiades, P. (2000). Beyond conceptual change learning in science education: focusing on transfer, durability, and metacognition. *Education Research, 42*(2), 119-139. https://doi.org/10.1080/001318800363773

Polit, D. F., & Beck, C. T. (2004). Multimethod Research Designs. *Nursing Research: Principles and Methods*, 7th Edition, p. 279.

Thomas, G. P. (2012). The Metacognitive Science Teacher. *Contemporary Science Teaching Approaches*, p. 29–48.

Welle, T., & Birkmann, J. (2016). *The World Risk Index 2016.* Retrieved from http://weltrisikobericht.de/wpcontent/uploads/2016/08/WorldRiskReport2016

Young, A., & Fry, J. D. (2008). Metacognitive awareness and academic achievement in college students. *Journal of the Scholarship of Teaching and Learning*, *8*(2), 1-10.

APPENDIX A

Motivational Activity:

Metacognitive Demands

Students will be asked to read aloud the lesson objectives:

"After our lesson on, I will be able to distinguish and differentiate among and between different Hydrometeorological Hazards; and I can recognize its impending signs."

Student-Student Discourse

"Think Pair Share"

Sharing prior knowledge about the ways they would learn best the concepts in science.

Guide: "*In science, I learn best when…For example…*

Lesson Proper

Student-Teacher Discourse

Cooperative Learning

Divide students into five (4) groups. Randomly assign a hazard exposure scenario for each of the four (4) groups. Formulate a rubric with the students.

Each group will discuss among themselves the following:

a. What they can do to prepare before, during, and after such events.
b. Enumerate the potential hazards of each scenario and they must list down steps that can be taken to monitor the phenomena and reduce damage.
c. Make a short script for a creative drama of the scenario

Each group should read aloud to the class their three questions/suggestions about their task.

Students' Voice and Distributed Control

After the presentation of each group, students will be asked about the following questions:

- How do you find the activity?
- What are the difficulties you have encountered during your task?
- If you will still be given the chance to repeat your performance task, how will you do it?

Synthesis

"3-2-1"

- Three (3) things I learned...
- Two (2) interesting facts...
- One (1) question I still have…

Teacher Encouragement

Provide constructive feedback and encouragement to improve students' performance. Encourage students to continue their good performances and overcome their weaknesses to improve science learning.

Valuing

Emotional Support

"Life Connections through Collage-Making". Inculcate life learning through experiences shared by the students.

APPENDIX B

Table 2. Nodes and their sources and references in the NVivo QSR analysis of students' reflections, 2017

Name of Nodes	Sources	References
• knowledge of his or her strengths, weaknesses, and learning processes	9	15
• ability to make self-corrections	8	14
• student-teacher discourse	7	12
• awareness of his or her repertoire of tactics and strategies	7	10
• planning cognitive processes	6	9
• conscious	5	9
• student-student discourse	6	8
• connecting new from old knowledge	6	7
• intentional	4	7
• foresighted	4	4
• purposeful	3	4
• awareness of how and under what circumstances learning tactics could enhance or inhibit learning and cognitive performance	3	3
• memory skills	3	3
• monitoring cognitive processes	2	2
• providing routine activities	2	2
• summarizing	2	2
• emotional support	1	1
• evaluating cognitive processes	1	1
• teacher modelling makes students learn from observing and copying behaviors and cognitive strategies	1	1

Table 3. Nodes and their sources and references in the NVivo QSR analysis of teacher's reflections, 2017

Name of Nodes	Sources	References
• student-student discourse- students discuss their science learning processes with each other.	2	6
• metacognition entails evaluation and reconstruction of existing ideas	2	5
• teacher encouragement & support - students are encouraged by the teacher to improve their science learning processes	3	4
• student voice - students feel it is legitimate to question the teacher's pedagogical plans and methods.	2	3
• metacognitive demands - students discuss their science learning processes with each other.	2	2
• metacognition is evaluating cognitive processes	1	2
• planning cognitive processes	1	2
• metacognition is monitoring cognitive processes	1	1
• metacognition is planning cognitive processes	1	1
• student-teacher discourse - students discuss their science learning processes with their teacher.	1	1

APPENDIX C

Table 4. Sample quotes and their implied subthemes for the Theme 1: "*Students' metacognitive abilities and skills*", 2017

Sample quotes	Subtheme
• …To understand the lesson, next time…*"I will try to search some additional information about disasters so that I have a lot of knowledge about our lesson."*	• Foresighted
• …I was able to achieve my learning goal by…*"doing great and to motivate to earn more perspective about DRRR subject."*	• Conscious
• …One thing my teacher did for this lesson that I liked best was… *"an activity which is 3-2-1 and making our future learning plan."*	• Planning cognitive processes
• …One thing my teacher did for this lesson that I liked best was….*"when I'm doing the activity by answering a question 3 Things I learn ,2 Interesting facts and 1 Question I still have, this type of question it can measurable to my mind if I have learned in the past lesson we discuss."*	• Monitoring cognitive processes
• …To understand the lesson, next time…*"I will try to take down notes and study hard for effective learning to happen."*	• Ability to make self-corrections
• …I was able to achieve my learning goals because…*"I really understand the topic even though it's too hard to draw the school campus, I finish it through the help of my teacher and classmate."*	• Evaluating cognitive processes
• …My learnings in this lesson are… *"I realize that it is so effective if we use our knowledge in real situations."*	• Awareness of his or her repertoire of tactics and strategies
• …To understand the lesson, next time…*"I will try to review and to read books that have a different phenomenon that may help in my study so that I will understand properly what our teacher is discussing us in front."* …I could achieve my learning goals because … *"I can answer the activities given to us every day."*	• Awareness of how and under what circumstances learning tactics could enhance or inhibit learning and cognitive performance
…One thing my teacher did for this lesson that I liked best was… *"she asked everyone to make a collage because I can use and apply my creativity."* *"…There are no difficulties that I've encountered in the lesson because I always do my best to understand the lesson clearly."*	• Knowledge of his or her strengths, weaknesses, and learning processes

Table 5. Sample quotes and their implied subthemes for the Theme 2: "*Teacher's deliberate actions to develop students' metacognitive abilities and skills*", 2017

Sample quotes	Subtheme
• …I could achieve my learning goals because …*"I was determined to learn."*	• Intentional
• …I could achieve my learning goals because … *"I did my best especially when we do a hazard map."*	• Purposeful
• …The difficulties I encountered in the lesson are…*"to follow and memorizing the different hydro meteorological hazards precautionary measures that every group presented."*	• Memory skills
• …One thing my teacher did for this lesson that I liked best was…*"she gave examples and synthesize the topic carefully."*	• Summarizing
• …One thing my teacher did for this lesson that I liked best was…*"When she always giving us an activity to answer every day so that this activity can help us to enhance our knowledge through different objectives she gives us."*	• Providing routine activities
• …One thing my teacher did for this lesson that I liked best was…*"I like all what my teachers do that's why I always appreciate what we do."*	• Emotional support
• ..One thing my teacher did for this lesson that I liked best was…*"When she gave us an activity wherein we were asked to present the pictures of different disaster and we did a short headline about the picture and then she later explained them very well."*	• Student-teacher discourse
• …One thing my teacher did for this lesson that I liked best was…*"when she recalls our lesson by an activity about the impending signs of hydrometeorological hazards then she gave us an activity that we will present different situations she had given for us."*	• Connecting new from old knowledge
• …I can apply my learnings in this lesson by…*"sharing it to my friends and classmates so that we can determine the hazard area and safe area."*	• Student-student discourse

Table 6. Sample quotes and their implied subthemes for the Theme 1: "*What metacognition is*", 2017

Sample Quotes	Subtheme
…Next time, I will repeat…*"writing essay about "My Future Learning Plan."*	Metacognition is planning cognitive processes
…I encouraged learner autonomy and metacognitive skills to my students through…*"asking them to think about their experiences and/or observations and then apply it to their group task."*	Metacognition is monitoring cognitive processes
…I make my students aware of their learning by…*"checking the script they have written based on the rubrics they formulated; and writing a reflection paper using the "Student's Reflection Guide"."*	Metacognition is evaluating cognitive processes
"…evaluating their learning through a "guessing game" activity which made them realize the concepts they learned as they think and answer the given questions; and writing a reflection paper using the "Student's Reflection Guide". *"…giving guide questions to the students to think about the previous activity; understanding the importance of hazard maps; and evaluating their own output based on the rubrics."*	Metacognition entails evaluation and reconstruction of existing ideas

Table 7. Sample quotes and their implied subthemes for the Theme 2: "*Design of a metacognitively-oriented pedagogy*", 2017

Sample Quotes	Subtheme
"…the "Think-Pair-Share" wherein students were asked how they learn best in science, think about their science learning and share it with their partner."	Encouraging students to be aware of how they learn and how they can improve their science learning. (Metacognitive demands)
...The strategies and tools I use to promote metacognition to my learners are…*"thinking about their best learning strategy in science and relating the concepts/subject content to their lives."*	Help students to discuss their science learning processes with their teacher (Student-teacher discourse)
"…students may ask and suggest during the group activity."	Letting students to feel it is legitimate to question the teacher's pedagogical plans and methods (Student voice)
"… Cooperative learning activity" wherein the students discuss among themselves the learning task and giving them the chance to ask questions about the given task on them." *"…providing them a "room" for their group discussion for them to express freely his/her own ideas."* *"…the sharing of one's best learning strategy in science and creating a "news headline" based on prior knowledge and experiences."*	Allowing students to discuss their science learning processes with each other (Student-student discourse)
"…may affect the student's feelings during the evaluation and giving of feedback to their presentations." *"…more concerned to my students"* *"…providing encouragement to improve their learning process."*	Encouraging the students by the teacher to improve their science learning processes (Teacher encouragement and support)