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**Thematic Analysis on the Teachers'  
Dialogic Scaffolding Practices and  
Students' Expressions of  
Argumentative Agency**

과학 논변 수업에서 나타나는 교사들의 대화적  
스캐폴딩 실행과 학생들의 행위주체성 탐색

**Doctoral Dissertation  
Science Education (Biology Major)**

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# **Thematic Analysis on the Teachers’ Dialogic Scaffolding Practices and Students’ Expressions of Argumentative Agency**

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**Submitting a Ph.D. Dissertation in Education**

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# Dedication

To my parents who instilled in me the love of wisdom;

To the students who continue to seek wisdom;

To all researchers and educators who inspire others through their wisdom;

And to God Almighty who is the ultimate source of all wisdom.

*-sally-*  
*(Fall 2016-Spring 2019)*

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## **Abstract**

The study thematically explored the teachers' dialogic scaffolding practices and strategies in classroom argumentation implementation. As dialogic inquiry involves interrelated responses, students' expressions of argumentative agency in response to their teachers' dialogic scaffolding were also thematically explored. This study was conducted to investigate the potentials of classroom argumentation to become a minds-on inquiry teaching method in the Philippine biology education due to the limitations of schools for hands-on or laboratory-based instructions.

The study employed the qualitative multiple-case study research design which involved four science teachers and their students in the Philippines. Robust amount of data which were analyzed through constant comparison method to establish themes representative of the teachers' dialogic scaffolding and students' expressions of argumentative agency were taken from audio- and video transcripts of a total of 20 lesson transcripts; five lessons observed from each teacher. These were supplemented with other data obtained through survey, formal and informal interview, and non-participant observations to establish the teachers' profile regarding their knowledge and beliefs on the nature of teaching and learning and on the nature and advantages of classroom argumentation.

Thematic analyses for both the teachers' dialogic scaffolding practices and students' expressions of argumentative agency in both the contingency and fading phases followed the grounded theory methodology through constant comparison method. This was applied to the total of 20 classroom transcripts (five from each) of the four classes to develop the themes and subthemes which represented the interrelated categories of teachers' and students' dialogic exchange which sustained their argumentative discussions from the contingency phases to the fading phases. In the coding process, themes were developed using the combined inductive and template approaches which merged the a priori and data-driven codes. The codebooks that were generated were particularly focused on types of dialogues



and the roles played by these dialogues to establish the interplay of teachers' and students' dialogic interactions.

Dialogic scaffolding in this study was used as discursive support provided by the teachers to elicit students' expressions of argumentative agency. Students' expressions of argumentative agency on the other hand, were focused on their willingness to participate in the dialogic inquiry with solicited responses in the contingency phases and unsolicited responses in the fading phases. As the study was focused on the dialogic exchange, the roles of the teachers' dialogic scaffolding prompts and students' responses were noted in both the contingency and fading phases of their discussions. Teachers' dialogic scaffolding prompts were classified as conceptual, analytical, and reflective and were expressed in different roles such as linking statements to prior knowledge, recapitulating, appropriating, recasting, cued eliciting, and increasing perspectives in the contingency phase while supporting, being a tool for communication, and extending students' capacities in the fading phase. Students' dialogic roles to express their argumentative agency on the other hand, can either be constructive which supported or provided reasons to claims or critic which clarified, challenged, or evaluated existing claims.

Results showed that the teachers had different dialogic scaffolding practices for classroom argumentation implementation. These differences were affected by their varying levels of knowledge and beliefs on the nature of teaching and learning and on the nature and advantages of classroom argumentation. These beliefs eventually affected their framing of instructional approaches to implement classroom argumentation (SSI-based or content-based) which further influenced their dialogic scaffolding practices and strategies. Four themes, which were associated to their framing of instructional approaches, emerged as the teachers' dialogic scaffolding practices in the contingency phase namely: 1) appropriation strategies, 2) enactment of the culture of negotiation, 3) conceptual-reflective

questioning, and 4) flexible affirmations of students' ideas for collective consensus. In the fading phase, two themes represented the teachers' dialogic scaffolding and similarly, these were aligned to their instructional approaches to classroom argumentation implementation.

In order to implement their personal dialogic scaffolding practices, each teacher employed two different but related dialogic scaffolding strategies to support the students' expressions of argumentative agency in the contingency phases. In the SSI-based classes, using the appropriation strategies, Teacher Loida dialogically scaffolded the students by: 1) using prior scientific knowledge to build abstract concepts from simple ones, and 2) providing scenarios that may be experienced by the students. In the enactment of the culture of negotiation, Teacher Carlo used the strategies: 1) offering neutral points of view as prerequisites for integrative negotiation, and 2) converging disparate ideas leading to collective consensus. In the content-based classes, Teacher Don implemented his conceptual-reflective questioning by: 1) questioning using factual-canonical concepts, and 2) extending discussion through reflective inquiry. Finally, using the flexible affirmations of students' for collective consensus, Teacher Mara implemented this by: 1) providing reinforcement for a mutually contingent dialogic exercise, and 2) revocicing to increase students' backing and enhance their discursive identity.

Results of the analysis point out the possibility of implementing classroom argumentation as a minds-on inquiry process in the Philippine biology education. This is in response to the advocacy for inquiry-based teaching despite the limits posed by the scarcity of resources for hands-on or laboratory-based inquiry teaching practices. With the varying dialogic scaffolding practices of the teachers employed in this study based on their varying levels of knowledge and beliefs on the nature of teaching and learning and on the nature and advantages of classroom argumentation, the study recommends professional development (PD) programs that would facilitate the development of the constructivist beliefs of pre-service and

in-service education. This would eventually lead them to framing and implementing inquiry-based teaching such as classroom argumentation through their dialogic scaffolding. Implications for pre-service and in-service teachers' PDs which aim to maximize the use of language in promoting classroom argumentation with the success of the mother tongue-based-multi-language Education (MTB-MLE) program in the Philippines were discussed. Further recommendations for future related studies were discussed.

*Keywords, argumentative agency, argumentative map, contingency, dialogic scaffolding, fading, scaffolding*

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# Chapter 1. Introduction

The essential goal of science education is the development of learners' scientific literacy (American Association for the Advancement of Science [AAAS], 1993; National Research Council [NRC], 2012a). This goal is stipulated in most national and international science education standards' advocacies (ACARA, 2012; NRC, 2012a; U.K. DCSF, 2009). In their advocacies, the educational objectives must be centered on the aspects of the nature of science (NOS) and scientific practices such as evidenced-based argumentation in the learning of science content (Lederman & Lederman, 2014; NRC, 2012b). Thus, many countries across the world have recognized the significance of scientific inquiry and are driven to promote the incorporation of scientific argumentation in the teaching and learning processes (Cavagnetto, 2010; Duschl, 2008; Jiménez-Aleixandre & Crujeiras, 2017).

In the Philippines, as the science education curriculum recognizes the role of science and technology in human lives, "it envisions the development of scientifically, technologically, and environmentally literate and productive members of society who are critical problem solvers, responsible stewards of nature, innovative and creative citizens, informed decision makers, and effective communicators" (Official Gazette of the Republic of the Philippines, n. d., p. 2). Thus, the curriculum guide promotes the simultaneous learning of science content and processes through inquiry-based learning methods with emphasis on evidences in constructing explanations. Moreover, it is organized "around situations and problems that challenge and stimulate learners' curiosity, motivation, and appreciation of science learning as a relevant and useful endeavor" (Official Gazette of the Republic of the Philippines, n. d., p. 2).

Dialogic scaffolding in this study was used as supporting and eliciting the willingness of the students to participate in an argumentative discussion using dialogic prompts. Dialogic prompts were usually framed within their zone of

proximal development and stages of learning development so that they are able to grasp the meaning of the statements which encouraged them to share their prior knowledge or experiences. Through these dialogic prompts, they can be agents in the argumentative discussions when their responses serve as dialogic prompts for others to participate or to the succeeding prompts of their teacher. It is however, important to emphasize that teachers' dialogic scaffolding in this study concerned the students' reasoned arguments. These prompts come in any type such as conceptual, analytical, or reflective dialogues which were interrelated with each other as the argumentative agencies of the students were developed from the contingency to the fading phases.

In this study, it was hypothesized that teachers' knowledge and beliefs on the nature of teaching and learning and on the nature of classroom argumentation affected their instructional approaches to classroom argumentation implementation. These would further influence their dialogic scaffolding practices and their implementation strategies. This hypothesis was based on previous studies which claimed that successful implementation of classroom argumentation requires teachers' constructivist beliefs, enough PCK on classroom argumentation, awareness on the nature of the students, and enough skills on inquiry-based practices (Beyer, Delgado, Davis, & Krajcik, 2009; Davis & Krajcik, 2005; NRC, 2012b). Thus, these were also explored for each teacher and were analyzed to understand the similarities or differences which inform their dialogic scaffolding practices and strategies in both the contingency and fading phases.

Students' expression of argumentative agency on the other hand, was characterized as their willingness to participate in the discussions without fear of being halted in the process. Through the teachers' dialogic scaffolding roles, their responses were ensured of a healthy skepticism making them realize that with the diverse knowledge existing in the classroom from all of their peers, their claims can anytime be refuted with other valid evidences. Argumentative agency was not

confined to purely expressions of critical thoughts. As the learning environment was focused on cooperative argumentation, competing claims were being resolved with supportive and converging ideas that eventually led to consensus. Thus, in expressing argumentative agency, students' dialogues functioned as either constructive or critique to each other in a sound learning environment.

The NRC, through its Next Generation Science Standards(NGSS) suggests that science classrooms must deeply engage students in evidence-based arguments (NRC, 2012b). Acknowledging the role of language in developing their communication skills through argumentation will lead to students' expressions of their argumentative agency while simultaneously developing their critical thinking skills in strengthening their scientific claims. Thus, science teachers should be responsive enough to dialogically scaffold them in argumentative discussions. Moreover, they should be willing enough to shift from the traditional initiation-response-evaluation (IRE) type of classroom discussion to argumentative type of instruction. Moreover, to facilitate and support a shift towards argumentative classroom, it is imperative that they recognize the varied ways of instructional strategies that support discourse norms (Kuhn & Reiser, 2006).

Recognizing the learner-centered inquiry, the Philippine science education curriculum integrates the principles of learning and development such as constructivism, social cognition learning model, learning style theory, and brain-based learning (Official Gazette of the Republic of the Philippines, n. d.). This is with the goal of making students perform scientific processes and skills, develop and demonstrate scientific attitudes and values, and understand and apply their scientific knowledge not only in the local setting but also in the global context (Official Gazette of the Republic of the Philippines, n. d.). Thus, various approaches for learning science leading to these goals were recommended such as inquiry-based approach, multi/interdisciplinary approach, science-technology-society (STS) approach, contextual learning, and problem/issue-based learning

(Official Gazette of the Republic of the Philippines, n. d.).

With the influence of science to the many aspects of modern life, giving Filipino students a share of understanding science as a practice is important as members of the society so that they are able to make sense of information that they continuously receive about the natural world (NRC, 2012a). Moreover, this would encourage them to participate in the social construction of their knowledge, all the while gaining a rich understanding of the nature of science (Osborne, 2014). Thus, in accordance to the claims of Berland and colleagues (2016), Filipino science educators must also embrace their role in making science content enhance the students' engagement in the construction, critique, making informed decisions, and justification of their knowledge claims about science-related issues as active participants in scientific inquiry.

Argumentation requires a network of communication wherein students interact directly with their peers and with their teacher with the goal of engaging in a critique (Henderson, MacPherson, Osborne & Wild, 2015), sense making (Berland & Reiser, 2009) and persuasion—processes known to drive instruction in an argumentative classroom. In this process, learners engage in a “grasp of practice” where they assume the role of both the constructor and critic to formulate scientific claims and show appropriate reasons for how, under what circumstances, and why a scientific claim is needed to be critiqued (Ford, 2008, 2012). As learners engage in this practice, they become accustomed to the social and material aspects of science, collaboratively construct content knowledge, practice critical reasoning skills, and develop accountability in communication. Therefore, science teachers are highly encouraged to scaffold students' engagement in classroom argumentation.

As one of the basic components, counterargument can establish the relationship between NOS and argumentation. Generally, constructing counterarguments can impact the three aspects of the nature of science namely:

subjective, empirical, and tentative aspects. First, being aware of the existence of alternative views when constructing counterarguments makes students understand the subjective aspect (Khishfe, 2014). Second, the generation of valid evidence in presenting counterarguments makes them understand the empirical aspect (Khishfe, 2014). Lastly, emphasizing the existence of counterarguments strengthen their conceptions on the tentative aspect of NOS (Kuhn, 1991). Through teachers' framing of their instructional approaches towards argumentation and dialogic scaffolding, they can share their own inherent views on the NOS during their dialogic interactions. This will eventually lead to discursive and dynamic interactions that revolve around mutual and active facilitation of the teaching and learning processes in the quest for understanding the relevance of learning science to the society.

Science education researchers explicitly recommend capitalizing on the students' NOS understanding transforming naïve conceptions to informed ones. This can be accomplished using argumentation where students are exposed to the applications of scientific ideas and reasoning about the emerging issues that demand moral, ethical, and social concerns (Osborne, Erduran, & Simon, 2004). Knowing and applying the different components of argumentation develop the students' conceptions of the aspects of NOS in various ways. When students engage in argumentation, they construct and reconstruct their own knowledge as they recognize the coordinated role of claim, evidence, and justification. Using evidence, students are able to understand, generate, and respond with multiple perspectives when engaging in argumentation (Oh & Jonassent, 2007).

As prime actors in the learning process, teachers play important roles in creating a learning environment which promotes accountable talk and allows students to construct and defend knowledge claims as well as critique and elaborate on each other's ideas (Alozie, Moje, & Krajcik, 2010; Osborne et al., 2013). How they interact with students is a major factor in establishing a classroom

environment that supports authentic inquiry and develop students' intrinsic motivation to engage in further learning. In order to understand the factors influencing their implementation strategies, a wide array of research has focused on the exploration of the relationships between teachers' knowledge, beliefs, and practices about teaching and learning and classroom argumentation (Chen, Morris, & Mansour, 2014; Capps & Crawford, 2013; Mansour, 2013). McNeill and Knight (2013) claimed that science teachers' beliefs and knowledge on the importance of argumentation may or may not be translated into their instructional practices. Also, even if they have enough understanding on the structural elements of an argument, they may still struggle to turn their knowledge into practice or they may fail to evaluate how students support their claims with evidences.

Previous researchers presented different ways on how teachers implement scaffolding methods in an argumentative classroom (McNeill & Pimentel, 2010; Martin & Hand, 2009; Simon, Erduran, & Osborne, 2006). According to Martin and Hand (2009), it can be implemented from factual or recall questions to more open-ended ones that would encourage greater participation. Through this, students are stimulated to provide concrete scientific evidences for their claims and rebuttals. Likewise, making students reflect during class discussions using open-ended questions improves their argumentative interactions when they engage in a dialogic exchange of ideas by either supporting or refuting the ideas of their peers (McNeill & Pimentel, 2010).

With the struggles of Filipino science teachers about hands-on and laboratory-based inquiry teaching, acknowledging the role of language is one of the most efficient tools for interaction in the classroom argumentation. This can be implemented through their dialogic scaffolding with the aim to establish a coherent line of thinking and conceptual understanding with their students. This then, makes classroom argumentation a minds-on inquiry learning process that would focus on the development of students' conceptions on the nature of science with science

content in a dialogic manner. Moreover, as teachers exercise their constructivist beliefs, they can increase the responsibility of their students to achieve their lesson goals when they allow them to question, verify, and ask for elaborations during their dialogic inquiry. Through this, they are able to scaffold the students' social and cognitive learning processes as well as their expressions of argumentative agency.

In this study, it is hypothesized that teachers who possessed constructivist beliefs and knowledge on classroom argumentation would have the potential to dialogically scaffold their students' expressions of argumentative agency during argumentative discussions. Guided by the principles of the sociocultural theory (SCT) of learning and development and the zone proximal development (ZPD), constructivist teachers can encourage their students to share their personal sociocultural values, prior knowledge, and preconceptions which can be sustained with increasing levels of reasoning when they continue to formulate higher-level questions for deeper understanding.

By understanding the varying levels of teachers' knowledge and beliefs systems on the nature of teaching and learning, the research explored what were their dialogic scaffolding practices in order to implement classroom argumentation as a minds-on inquiry process in the science teaching and learning in the Philippine science classes. In response to their dialogic scaffolding practices, the students' expressions of their argumentative agency were also explored. This was with the goal of understanding the dynamics of interactions in a dialogically-scaffolded classroom argumentation. Moreover, with the goal of informing the policy-makers in the future about the status of classroom argumentation in science education in the Philippine high school biology classes, this study tried to understand how classroom argumentation would respond to the challenges that teachers continuously face due to their limited resources for hands-on and laboratory-based inquiry. Further, with the constant influx of socioscientific issues such as stem cell

research and cloning in the society, this study responds to the call stated in the science education curriculum standards to develop Filipino learners' critical thinking and decision-making skills through classroom argumentation. Using thematic analyses of teachers' dialogic scaffolding practices and strategies to elicit their students' expressions of argumentative agency, this study would inform the Philippine education sector on how to develop the teachers' skills to frame their classrooms towards dialogic inquiry particularly in classroom argumentation.

### **1.1. Statement of the Problem**

This study hypothesized that teachers' enough knowledge and beliefs on the nature of teaching and learning and on the nature and advantages of classroom argumentation motivated them to recognize that scientific knowledge are jointly constructed in the teaching and learning process. Moreover, with their significant knowledge and beliefs, they were able to frame their instructional approaches toward evidenced-based learning through classroom argumentation. Therefore, with their recognitions on the constructivist nature of teaching and learning through inquiry-based practices such as classroom argumentation, it follows that they can maximize the benefits of the dominant existence of language in their classrooms to implement argumentation with the goal of eliciting their students' expressions of argumentative agency through various dialogic scaffolding prompts. Through their dialogic scaffolding, students will acquire the skills essential to formulate reasoned arguments with significant and valid evidences progressing from the contingency to the fading phases of their dynamic interaction.

Blending the underpinnings of the theories of Piaget, Vygotsky, and Ausubel, inquiry-based teaching and learning emphasizes the active involvement of learners in the process of integrating prior and existing knowledge (Kirschner, Schweller, & Clark, 2006). However, much as the Philippine science education curriculum is advocating inquiry-based approaches, the country's education sector is facing various challenges that hinder the effective implementation of these



approaches. In a previous study, Gutierrez (2015) identified three factors which limited the enactment of inquiry-based approaches in the classroom namely: lack of support, training, and available inquiry-based materials, overemphasis on assessing content learning rather than process learning, misconception, difficulty, and time-consuming nature of inquiry approach. In this study, findings revealed that teachers possessed the misconceptions on inquiry-based teaching to be solely implemented through hands-on activities or laboratory activities. These misconceptions mostly resulted to teachers' anticipated plans for the traditional lecture-based patterns of discussions deprive of students' development, participation, and application of their critical thinking skills in knowledge construction. Thus, this study explicated classroom argumentation as one of the inquiry-based approaches that can be implemented given the scarcity of laboratory materials for hands-on inquiry-based science teaching strategies.

With the previous claims linking the development of knowledge and understanding to talk and inquiry, classroom dialogues can facilitate the shared understanding and deep learning among students (Howe & Abedin, 2013; Wells, 2007). As such, it should be a norm for teachers to encourage interactions by giving enough student-student scaffolding (McNeill & Pimentel, 2010) so they can actively share insights as they explore and articulate the importance of scientific ideas on their personal lives. Recognizing the value of language and the dialogic interactions in argumentation, teachers can take advantage of 'talk' in the classroom as a minds-on inquiry-based activity for the students (Polman & Pea, 2001; Tabak & Baumgartner, 2004). Through language, students' responses can be dialogically scaffolded by teachers' prompt statements to increase their participation in an argumentative classroom setting. Through teachers' dialogic scaffolding, 'interthinking' collective argumentation would be enacted and students' expressions of their argumentative agency can be promoted with the utility of language as the most dynamic tool for inquiry-based teaching.

In order to facilitate and support a shift towards argumentative classroom, it is imperative to recognize the varied ways of instructional strategies that support discourse norms (Kuhn & Reiser, 2006). Using dialogues as scaffolds for classroom argumentation, novice students are guided and classroom communication is facilitated when teachers employ a wide variety of discursive roles to encourage their practice of their argumentative agency. Minimizing the usual immediate evaluative statements, classroom interactions can be directed towards the active process of teacher-student and student-student interactions, thus being responsive to each other's capabilities to establish a mutual understanding.

In the studies which were focused on knowledge building, students' epistemic agencies have been linked to their full engagement in the learning process (Zhang et al, 2009). According to Greeno, (2006), the role of social practices in creating varied learning opportunities has been an important factor in promoting students' epistemic agency. However, previous studies claimed that in any traditional classroom, interactional resistance is prevalent when students view their teachers as authorities (McFarland, 2001; Evertson & Weinstein, 2013). Thus, considering the atmosphere of an argumentative classroom, teachers' dialogic scaffolding can be used to elicit students' participation as well as encourage the expressions of their argumentative agency so that knowledge construction is collectively shared in a joint interactive space of mutual respect and reciprocity. In the process, students will eventually recognize the value of collaborative learning as they assume the responsibility in the dialogic exchange of insights towards advancing their own scientific knowledge and skills.

Linking the principles of ZPD to scaffolding, teacher's dialogic prompts must be dependent on the potential abilities of the students to create an argumentative discussion. This usually starts at the contingency phase that slowly progresses to the fading phase when the teachers try to establish an interaction using their dialogic prompts making students engage in discussions within their

own motivational and cognitive capacities. Thus, exploring the effects of their knowledge and beliefs on the nature of teaching and learning and on the nature and advantages classroom argumentation, this study was focused on understanding the teachers' dialogic scaffolding practices for students' expressions of argumentative agency in both the contingency and fading phases of their argumentative discussions. Centered on dialogic exchange, the study did not include the third phase which is transfer of responsibility with the rationale based on the scaffolding principle that when students had already reached the transfer of responsibility phase, the teacher is no longer needed in the process when they are already competent enough to recognize the skills needed in the accomplishment of tasks.

To establish the overall implication, this study investigated the status of classroom argumentation with an aim to recommend its possible implementation as an inquiry-based learning approach in science education in the Philippines. This is in response to the visions of the Philippine K to 12 curriculum to implement inquiry-based approaches in science classes. Through this teaching approach, teachers and students interact with each other through shared dialogues highlighting the importance of including the aspects of NOS in their classroom-based social interactions involving scientific meaning making. Moreover, using classroom argumentation, the Philippine science education would take advantage of the successful institutionalization of the mother tongue-based multilingual education (MTB-MLE) (DepEd Order No. 74, 2009) which was claimed to be embedded in the social development of the Philippines (Tupas, 2008). Maximizing the use of language in classroom argumentation, teachers can therefore dialogically scaffold the students' expressions of their argumentative agency as they facilitate the development of their scientific literacy while acquiring science conceptual knowledge.

## **1.2. Objectives of the Study**

The overall aim of the study was to explore the dialogic scaffolding practices of the teachers for the students' expressions of argumentative agency in the contingency and fading phases of classroom argumentation. As presented in the rationale, teachers' framing of classroom implementations towards argumentation was linked to their knowledge and beliefs on the constructivist nature of teaching and learning as well as on the nature and advantages of classroom argumentation as one of the inquiry-based process in learning science. Analysis revealed that the four teachers involved in this study had varied levels of knowledge and beliefs. Thus, a background information on their knowledge and belief systems were presented from the descriptive analysis of the survey and interview data in order to establish the reasons on the differences in their dialogic scaffolding practices for students' expressions of argumentative agency in an argumentative classroom.

Using the qualitative multiple case study approach, thematic analyses were conducted to identify the dialogic scaffolding practices of the teachers in both the contingency and fading phases and their strategies on how they were able to implement these dialogic scaffolding practices. Moreover, as the students' science competencies were the target of these dialogic scaffolding practices, their responses to the dialogic scaffolding practices of their teachers in both the contingency and fading phases of the classroom argumentative scenario were identified and explained.

Specifically, the research questions that guided this study were:

1. What were the teachers' dialogic scaffolding practices and how did they implement these for students' expressions of argumentative agency in both the contingency and fading phases of classroom argumentation?
2. What were the teachers' knowledge and belief levels on the nature of teaching and learning and on the nature and advantages of classroom argumentation which affected their framing of instructional approaches

and their dialogic scaffolding practices and implementation strategies?

3. What argumentative agencies were expressed by the students in response to their teachers' dialogic scaffolding and how did these manifested in both the contingency and fading phases of classroom argumentation?

### **1.3. Significance of the Study**

As an attempt to address the gap in science education literature, the findings of the study presented how classroom argumentation can be implemented in both content-based and SSI-based biology classes. Based on the thematic analyses, the study showed how classroom argumentation can be implemented through different methods of teachers' dialogic scaffolding practices in both the contingency and fading phases. Moreover, obtaining the background information on the knowledge and beliefs of teachers on the nature of teaching and learning and on argumentation, the study presented how these influenced their framing of their classes towards classroom argumentation which eventually affected their dialogic scaffolding practices and strategies.

In the context of the Philippines, results of the study can be used as benchmark information on how classroom argumentation can be implemented in biology classrooms as one of the minds-on inquiry-based approaches where hands-on and laboratory-based instructions are not possible due to the scarcity of materials and large classroom sizes. The study was also important as it presented how recognizing and maximizing the role of language can be a promising tool for inquiry-based teaching through classroom argumentation.

As expressions of their argumentative agency, identifying the responses of the students to their teachers' dialogic scaffolding practices also presented the dynamic interplay of their dialogic roles with their teachers' dialogic scaffolding prompts during the implementation of classroom argumentation. Mapping the dialogic interactions, the study showed the depth of discursive interactions and the chains of reasons as products of their extended discussions. Given that

argumentative mapping would be done in dialogically-scaffolded classrooms, understanding these maps would later help teachers to track the interaction capacities of their students and acknowledge the importance of their dialogic prompts in both the contingency and fading phases of their dialogic scaffolding process. Since the study cannot be generalized for the whole science education in the Philippines, looking into the different cases explored in this study would present similar scenarios that can be understood based on the results.

Taking the case of the simple constructive argumentative map, this study presented the importance of the dynamic assessment or contingency in extending the peer-to-peer interactions of the students during their expressions of argumentative agency. Moreover, understanding this map in the SSI-based classes, the study presented the significance of the teachers' delay of their evaluative prompts when the applications of science content called for more areas of understanding. In the content-based classes, the teachers' contingent dialogic prompts to increase their students' perspectives to answer their own questions were inferred as means to enhance students' capacity to express their prior knowledge related to the current topic as they collaboratively reach the consensus and achieve their lesson objectives. Thus, the study showed how the facilitator roles of the teachers as products of their constructivist beliefs impacted their framing of instructional approaches to argumentation implementation which influenced their dialogic scaffolding for students' expressions of argumentative agency.

Aligned with the constant assessment of the teachers' and students' performances in science education due to the newly-implemented K to 12 curriculum in the Philippines, the knowledge generated in this study would be a source of understanding similar classroom scenarios which were represented by each case. Moreover, this study would also provide insights on how to update the pre-service teacher education in the Philippines on how to develop the dialogic scaffolding practices as pedagogical approaches for teachers in order for them to

encourage more students' participation during their implementation of classroom argumentation. Further, for the in-service teacher education, the study presented ideas for teacher-educators on how they would frame their future teacher professional development efforts that would highlight dialogic scaffolding for effective implementation of classroom argumentation which would yield students' expressions of their argumentative agency. Finally, with the challenges of hands-on learning among classrooms in the Philippines due to large classes, utilizing the power of dialogue in the scaffolding students' inquiry learning process could be a minds-on strategy for responsive teaching and development of students' conceptual understanding.

#### **1.4. Limitations of the Study**

As a qualitative research, this study utilized extensive thematic analyses supplemented with exploratory analysis on the dialogic scaffolding practices and strategies for students' expressions of their argumentative agency. However, despite the robust amount of data used to identify these, several areas limited the generalizations that were generated. First, the study involved a multiple case study design. The generalized ideas were mostly conclusive to each of the cases and can only be applied to mirror the existing trends in those classrooms given almost similar features or related cases in the Philippine high school biology education.

The second limitation is the purposive sampling method. Much effort has been put into selecting schools with larger populations to represent the cases specified. However, since the study was mostly confined to the Northern part of the Philippines, other cases existing in the smaller island schools might be different from the cases presented. Nonetheless, the cases in this study can share similar features especially in the general public high schools in the urban areas like Metro Manila where most of the large schools in terms of population are located. Next, despite the robust amount of data representing classroom scenarios examined in this study, other grading periods in the academic calendar of the Philippines would

post different features of the lesson content. Finally, despite representing the cases of non-biology majors (similar to Teacher Don's case) who was assigned to teach biology, his method of implementing classroom argumentation might be different from other science teachers who are specialized in Chemistry, Earth Science, or General Science but are teaching biology which were not represented by his case. With all these predetermined limitations, exhaustive amounts of triangulated data were obtained in order to present unique features of each case that would inform the conclusions formulated in this study.

## **1.5. Overview of the Dissertation**

This dissertation is composed of seven chapters which were coherently written to answer the research questions and support the rationale for the conduct of the study. In Chapter 1, an introduction was presented to establish the research background. It specifically emphasized the importance of classroom argumentation in the development of students' critical thinking skills during their knowledge construction of biology concepts. In this chapter, a background of the need to implement classroom argumentation as one of the inquiry-based approaches in biology education in the Philippines was highlighted in response to both local and international standards. Moreover, classroom argumentation was presented giving emphasis on its potential to become a minds-on inquiry process which responds to the call of the Philippine science education standards to implement inquiry-based teaching as stipulated in the K to 12 curriculum guide. Also presented in this chapter are the objectives, significance, and the limitations of the study.

Chapter 2 presents the theoretical framework which supported the inquiry towards the development of this study. Various theories were explored, and their interrelationships were understood in order to establish the rationale of this study. The conceptual definitions of terms were also presented and how they were used in the context of this investigation.



Chapter 3 presents a comprehensive literature review which shows major findings of previous research that were conducted supporting the interpretation of the data in this study. Various subtopics were presented such as those studies previously explored about dialogic teaching and learning and its application in both elementary and secondary education and in teacher professional development efforts. Moreover, this chapter presents literature related to teachers' beliefs on teaching and learning, classroom argumentation, the nature of dialogic teaching, and epistemic agency. These were all understood to supplement the conceptualization of the rationale of the study. At the end of this chapter, the Philippine science education and the historical efforts of enhancing the constructivist and inquiry-based knowledge and skills of teachers were briefly presented which supported one of the criteria for selecting the teacher-participants.

In Chapter 4, the methodology was presented in detail. The research design was described and aligned with all the instruments that were used to obtain the data for this study. Moreover, a brief description of the research instruments that were used and how they were constructed and/or adapted, modified, and pilot-tested, were presented. Also found in this chapter are the data collection and interpretation procedures which presented how the thematic analyses were conducted that answered the research questions.

Chapter 5 presents the results and discussion and is divided into three sections; each section corresponds to how the research questions were answered in this study. The first section was focused on what were the dialogic scaffolding practices of the teachers and the strategies on how they were able to implement these in both the contingency and fading phases. The second section was focused on the descriptive analysis on the varying levels of teachers' knowledge and beliefs on the nature of teaching and learning and on the nature and advantages of scientific argumentation. The last section presents the students' expressions of argumentative agency in response to their teachers' dialogic scaffolding practices in

both the contingency and fading phases. The first and the last section which corresponds to the teachers' dialogic scaffolding practices and students' expressions of argumentative agency were supplemented with sample lesson transcripts that were discussed line-by-line. Moreover, students' expressions of argumentative agency were supplemented with argumentative maps which showed the patterns and trajectories of their chains of ideas that were dialogically scaffolded by their teachers particularly on the fading phases. Interpretations were embedded in the presentation of result. Thus, based on the themes, some of the emerging trends for dialogic scaffolding in classroom argumentation that can be utilized to support students' expressions of argumentative agency were presented. Relevant related studies were also considered and discussed to enhance the interpretations which served as back-up to the claims of the results of the study.

Summing all the results, analysis, and the discussion of the salient features of this study is the summary and conclusion presented in Chapter 6. After thorough analysis and interpretation of the results, this dissertation closes with Chapter 7 for the implications and the recommendations for future related investigations. Implications of the study were zoomed-in to the Philippine context as this can be considered as one of the pioneering studies conducted since the implementation of the K to 12 Curriculum. Moreover, implications were presented as the results suggest that classroom argumentation, which is one of the inquiry-based approaches in science education, can be implemented through dialogic scaffolding that may elicit the students' expressions of argumentative agency for a dialogic learning environment. Recommendations for future research were presented and were not only limited to the context of the Philippines but in all areas to which the similar cases presented in this research may be applied.

## **Chapter 2. Theoretical Framework**

This study was conducted to explore the status of implementation of classroom argumentation in the Philippine secondary biology education. With the hypothesis that teachers' constructivist knowledge and beliefs on the nature of teaching and learning and on the nature and advantages of classroom argumentation, these aspects were explored to explicate what their dialogic scaffolding practices were and how their levels of knowledge and beliefs affected their framing of instructional approaches and eventually their dialogic scaffolding practices. This was the product of extensive understanding on the previous studies which claimed that teachers who possessed constructive beliefs on the nature of teaching and learning were able to implement classroom argumentation. These knowledge and beliefs can be supplemented with the knowledge and beliefs on the nature and advantages of classroom argumentation which were acquired through experience or through formal and informal education.

To establish the rationale, the interrelated themes of constructivism, sociocultural theory, the zone of proximal development, and scaffolding were integrated to inform the effects of teachers' dialogic scaffolding for students' expressions of argumentative agency (Figure 1). First, this study captured the idea that teachers' implementation of classroom argumentation was dependent on their constructivist views of teaching and learning and their knowledge and views on the advantages of classroom argumentation as one of the inquiry-based approaches in science education. This was derived from the sociocultural theory whose main theme is centered on the premise that the process of learning and development is the product of the equal interactions of three factors: culture, social interaction, and language. In the process, it emphasizes the learners' active involvement in the learning process as they apply their previous knowledge in the construction of new knowledge (Bereiter, 1994). Thus, learning environments should be designed to actively involve learners in critical thinking and meaning making in their own ways

with enough teacher's facilitation—an approach to higher-order thinking and cognition instead of rote memorization (Ormrod, 2004; Prawat & Floden, 1994).

Second, in the learning process, activities in which the learners engage in collaboration with others enable them for initiative in their evaluation and supplementation of their previous knowledge, thus their learning yields better outcomes more than those done independently. This was based on the principles of the Zone of Proximal Development (ZPD) which posit that, by exploring the previous or actual level of a child (learner), one will be able to assess what a child (learner) can do independently in his development process. As teachers explore the students' ZPD and are involved in the learning process, they should act facilitators rather than direct transmitters of knowledge and that their instructional strategies must be designed to match and support the students' learning needs that will eventually provide them with opportunities for autonomy and self-discovery (Bonk & Cunningham, 1998). The synthesis of the ZPD is implicated in this study in the context of (dialogic) scaffolding that was applied in classroom argumentation. Teacher's dialogic prompts must be dependent on the potential abilities of the students to respond in an argumentative discussion. Dialogic scaffolding usually starts at the contingency phase when the teachers try to establish an interaction using their dialogic prompts and slowly progresses to the fading phase when students themselves engage in discussions within their own motivational, cognitive, and argumentative capacities.

The principles of scaffolding were also derived from the ideas of the ZPD. Simply put, scaffolding is the temporary and assisted learning which accumulates over time to establish independency in a dynamic system between the mentor (teacher) and the student. Moreover, it is the gradual development of confidence and capability of learners to accomplish tasks at hand (Lajoie, 2005). Understanding the dynamics of this system determines the interrelationship of the scaffolding phases: contingency, fading, and transfer of responsibility (Figure 1) in

the context of the actors involved in the process (i.e. teachers and learners). In the dynamic system of scaffolding, the contingency is the process wherein teachers tailor or customize their instructional strategies according to the students' capacities.

In this study, the teachers' dialogic scaffolding and students' expressions of argumentative agency were highlighted using the scaffolding phases. Since the study is focused on establishing a dialogic learning environment through argumentation, the teacher-student and student-student interactions were explored from the contingency and fading phases of the scaffolding process. Contingency is also termed as dynamic assessment with a premise that understanding the level of support at the contingency phase would help in the customization of the amount of scaffolding the mentors will provide for the learners that would lead them to the fading phase. Seeing it from the lens of dialogic scaffolding, teachers provide dialogic prompts and observe students' responses to determine the kind and level of support that would follow accordingly (van de Pol, Volman, & Beishuizen, 2010).

Initially termed as "providing just the right amount of support," the next phase of scaffolding is fading which was termed by Collins, Brown, and Newman (1989). According to Wood (2003), it refers to the provision of scaffolding that corresponds to the requirements of the developed skills from the learning tasks in the contingency or dynamic assessment. In fading, the mentor removes or lessens the intensity of the scaffolding based on the indicated level of improvement in the contingency phase i.e. the potential of the learners to work independently (Belland, 2017). It is important to note that fading is not necessarily the prerequisite of the transfer of responsibility in all cases; rather providing and allowing students to maintain independence in the accomplishment of the task can lead to transfer of responsibility. Therefore, in this study, as teachers gradually lessened their assistance to the students in the fading phase, there was an assumption that students

were enabled to express their argumentative agency.

Transfer of responsibility is the final phase of the scaffolding process. It is also termed as intersubjectivity and can be achieved by learners because of acquired knowledge and skills on how to perform the tasks from a series of support from the previous phases. As such, success is ensured even without any type of support as they had already gained the skills in accomplishing the tasks. The success of the performance on the various specific classroom tasks is therefore crucial to ensure the success in the performance of similar tasks that students will face in the future (Mortimer & Wertsch, 2003; Wood, Bruner, & Ross, 1976). In this study, this scaffolding phase was not included in the analysis because in understanding its premises, it can no longer be applied in the context of a dialogic teaching environment.

In summary, grounded on the idea of social interactions, dialogic scaffolding combines the ideas of constructivism, the sociocultural theory, and the ZPD in the social processes of achieving scientific reasoning and higher-order thinking skills. Vygotsky's use of language as a tool for cognitive development in the social phenomenon of knowledge acquisition in science education can therefore be dialogically scaffolded in classroom argumentation. The emphasis of active learning in social constructivism, the influence of culture, and the use of language in the co-construction of knowledge in SCT, and the concept of scaffolding of the ZPD encompass the logic behind the conduct of this study.

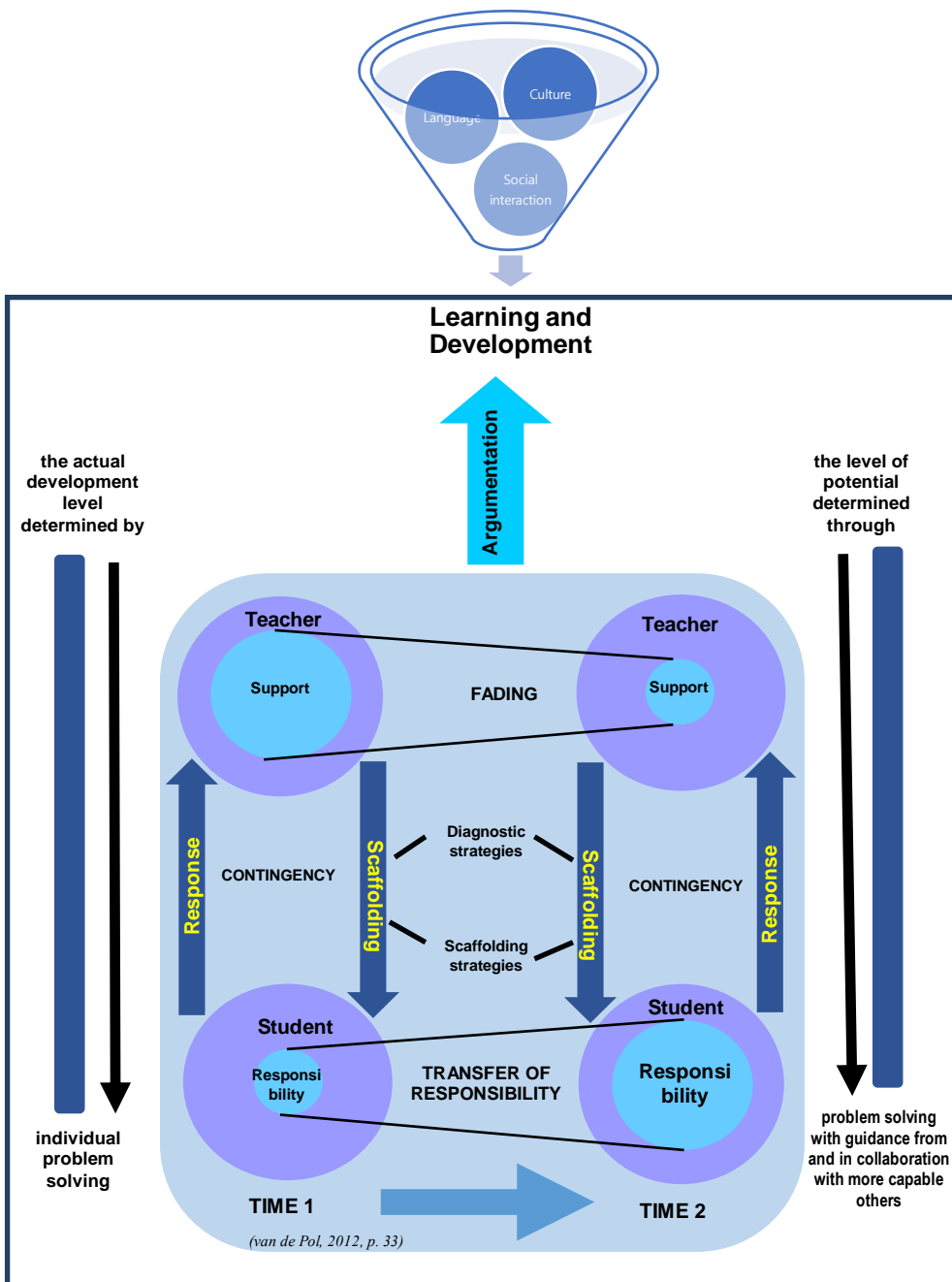


Figure 1. Interrelationship of the theories which established the rationale for the conduct of this study.

## Conceptual Definition of Terms

In this study, several terms which were used extensively were defined below. Most of the definitions were researcher-constructed based on how they were used in the context of this research. However, few definitions were adapted from literature in recognition of their conceptual definitions in alignment to the context of this study.

*Argument.* Without an explicit definition, it is a statement or a set of statements for a certain claim accompanied by a valid evidence and justification. It is usually subjected to counterargumentation or rebuttal which therefore requires the identification of various lines of thought.

*Argumentation.* It is a form of discourse which involves the various processes of systematically forming reasons, justifying beliefs, and drawing conclusions using claims, evidence, and justifications.

*Argumentative agency.* The willingness of students to participate in classroom argumentation through either solicited or unsolicited response

*Contingency.* This is the scaffolding phase where teachers adjust their teaching strategies according to their students' capacities.

*Counterargument.* It is a thoughtful assertion which is formulated in response to the disagreement of one's argument.

*Classroom argumentation.* This is the process of presenting, critiquing, supporting, or refining ideas in the classroom.

*Constructivism.* It is a paradigm or a worldview which proposes that knowledge construction entails the active participation of the learners as they bring their prior knowledge in the process, thus making the construction of new knowledge subjective.

*Dialogue.* It is the result of the dynamic interaction between two or more individuals directed towards a specific subject of inquiry.



*Dialogic.* This term is defined as a type of discourse associated with open mindedness, critique, and creative thinking, as opposed to monologic interactions limited to the transmission of fixed ideas (O'Connor & Michaels, 2007).

*Dialogic scaffolding.* Teachers' and students' use of statements which would elicit responses that would perpetuate the classroom argumentation

*Epistemic agency.* The ability of the students to participate in a joint-negotiation and co-construction of knowledge

*Fading.* This is the scaffolding phase wherein teachers slowly lessen the intensity of the scaffolding as a result of the students' developed capacities in the contingency phase.

*Scaffolding (in the learning process).* It is the temporary provision of assistance to learners in a dynamic system with the aim of building their autonomy in the process of knowledge construction.

*Rebuttal.* An assertion which challenges or presents that something is not true

*Teacher's beliefs.* These refer to the philosophy, tenets, or opinions of teachers about teaching and learning and on classroom argumentation

*Teachers' knowledge.* This refers to the awareness of teachers on the constructivist nature of teaching and learning and on the nature and advantages of classroom argumentation.

## **Chapter 3. Review of Related Literature**

This study which explored the teachers' dialogic scaffolding practices and implementation strategies and students' expressions of argumentative agency brings together three areas of educational research: dialogic teaching or inquiry, argumentative agency, and the factors that influence teachers' framing of instructional approaches for classroom argumentation. In this chapter, discussion of related studies that supported the rationale of the need to conduct this study was presented. The first parts focus on exploring related studies on dialogic teaching or inquiry which explicated the gaps in literature; mainly the promotion of argumentative agency in dialogic teaching has not been conducted particularly in high school biology education with instructional practices framed to be implemented either through SSI-based or content-based approaches. This was followed by clarifying the definitions of dialogic teaching that was used extensively in this study.

The second part presents studies and research-based definitions of scaffolding to facilitate the understanding on how dialogic teaching and scaffolding were coined as teacher variables that were focused in this study. Next, since this investigation supported claims that teachers' instructional framing towards classroom argumentation was affected by their knowledge and beliefs on the nature of teaching and learning particularly constructivism and the nature and benefits of classroom argumentation, the third section presents research-based efforts on how these knowledge and belief systems created impacts to teachers' explicit decisions to implement classroom argumentation in their science classes. Lastly, as the study was focused on the Philippine science education setting, the last part focuses on the local science education standards to promote inquiry-based teaching and the historical efforts of the education experts to enhance the inquiry-based practices of science teachers.

### **3.1. Dialogic scaffolding argumentation as an inquiry-based approach in science education**

In this research, it has been argued that classroom argumentation is an effective inquiry-based approach in science education. As such, it has been regarded in local and national standards that science education should be implemented through classroom argumentation where students are held responsible to formulate claims with reasoned arguments. In the Philippines, inquiry-based practices for science education has been fully-recommended and in fact, stipulated in the local science education standards. However, several reasons limit the implementation of classroom argumentation such as scarcity of resources, insufficient knowledge of science educators with the dynamics of classroom argumentation, and large classroom sizes (Gutierrez, 2015). Thus, classroom argumentation was hypothesized in this study to be one of the instructional approaches which can answer the call for inquiry-based strategies to science education in the Philippines. Moreover, it can be implemented using dialogic scaffolding utilizing language as the most dynamic interaction medium that dominates a class. It is thus hypothesized that through dialogic scaffolding, students' expressions of their argumentative agency will be elicited through various dialogic prompts which can be initiated by the teacher.

Most related studies on dialogic scaffolding have been focused to explore conceptual understanding. In the study of Rojas-Drummond et al. (2013), dialogic scaffolding was explored in collaborative group activities which were focused on the role of adult-children dialogic interactions. In this study, results showed that dialogic interactions between teacher and students were effective in enhancing children's understanding of the concepts behind HIV via mental maps. This was particularly observed when the teacher's dialogic scaffolding served as a sensitive and responsive intervention to elicit children's dialogues during their explanations of their conceptual maps. Through teacher's dialogic scaffolding, children's active

participation throughout their discussion was observed from the gradual increase in comprehensiveness and complexity of their concept maps to understand HIV concepts. Moreover, they claimed that the interactions that took place among the participants were dialogic since they illustrated a variety of communicative actions which were indicated in their analytical systems.

In the study of Teo (2016) which examined the dialogic space in teaching, findings explicated that the monologic patterns of teacher talk stifled the participation and cognitive engagement of pre-university students in Singapore. In this study, a closed case analysis of lessons taught by 18 teachers in seven schools was conducted. Results of this study adhered to the earlier findings which claimed that initiation moves that elicited pre-established or pre-determined responses as well as follow-up moves which do not probe further perspectives or opinions may impede the development of thinking process. Moreover, monologic talk moves tend to help students acquire factual knowledge similar to “fill in the blanks” activities which compromise the benefits of developing the critical and evaluation of skills of the students when their ideas are interrogated in an open space or dialogic teaching environment (Cazden, 2001).

Dialogic inquiry has also been explored in the areas of teacher professional development. In a study conducted among teachers, dialogic interaction was used as a framework for their professional development activity (Metzger, 2017). In this hermeneutic phenomenological study, high school teachers used reflective dialogues to understand the evidences of self-motivated learning from their dialogic interactions. Results showed that in their interactions, as teachers experienced the need for competency, autonomy, and connection, they were still engaged in the processes of making meaning of their experiences through exploration, storytelling, and critical reflection of their practices. These needs were however, addressed as they gave each other the space to reflect and overcome their personal and professional discomfort in their interaction processes. As the study

supported teachers' learning and motivation, it further recommended teacher professional development activities that would include dialogic reflection to facilitate transformational learning (Metzger, 2017).

Dialogic teaching was also examined in a teacher professional development using the dialogic video cycle (DVC) (Pehmer, Gröschner, & Seidel, 2015). This study developed a video-based program that both addressed classroom discourse, but differed with teachers' regard to the reflection component of their own teaching practice. The DVC was hypothesized that it will provide more students' learning opportunities as teachers relative frequencies of questions would be changed into opportunities which fostered elaboration of knowledge and feedback as scaffolding tool. As the experimental group of teachers did not show significant change in the frequency of their elaboration and scaffolding questions, they concluded that their professional development model further aims to be enhanced into a format that would capture teacher–student interactions and the discourse moves that teachers perceive as those that improve the quality of dialogic interactions more precisely (Pehmer, Gröschner, & Seidel, 2015).

Another study was conducted to explore the role of collectivity in dialogic teaching in the year-long teacher professional development of eight Czech teachers in lower secondary schools and their classes (Sedlacek & Sedova, 2017). In their analysis of classroom video recordings, they proposed that the quality of student talk was related to the number of students participating in the classroom discourse. Positive results revealed that through dialogic teaching, students were able to participate in a productive discourse characterized by increased complexity of their thinking and reasoning. Moreover, their findings contradicted previous studies which claimed that vocal students in class will force others with different types of talk patterns out of the discourse scenario. It was therefore implied that heterogeneity in the students' discursive abilities does not pose problems on the collectivity in the dialogic teaching approach (Kovalainen & Kumpulainen, 2007).

Muhonen et al. (2016) examined the dialogic teaching patterns and how teachers scaffolded children's participation and shared understanding in early school years of Finnish classrooms. Using 30 recorded lessons from pre-school to Grade 2, they found out that despite the scanty occurrences of child-initiated dialogues, teachers' dialogic scaffolding initiated the maintenance of interactional flow. Thus, they recommended that enhancing the child-initiated dialogues in early primary grades was specially needed in order to increase willingness of the children to actively share their thoughts and ideas. Teacher scaffolding may consist of listening and inquiry but making sure that they act as the facilitator of the dialogic exchange so that children's interactions would be enhanced (Muhonen et al., 2016).

In the earlier studies which developed the theory of dialogic teaching, Wegerif (2011) discovered that there are three concepts that are interrelated and associated to the dialogic teaching theory: dialogue, thinking, and learning. This was applied to the analysis of three short episodes of primary classrooms and positive results were obtained which claimed that thinking breakthroughs in primary classrooms require some sort of intersubjective mechanisms to open a space of reflective activities. The reflective spaces serve as sites where students set back to the dialogic interaction to allow their ideas to be self-evaluated as they try to reflect on the new insights that may lead to new visions when combined to their own (Wegerif, 2011). Thus, this study recommended further understanding on how individual skills change as well as how they develop self-identity when they are engaged in different kinds of dialogues.

With these existing studies connected to dialogic teaching and inquiry, the rationale of the study was established. First, it explored what are the dialogic scaffolding practices and implementation strategies that can be observed in a classroom with pre-planned argumentation as the inquiry-based approach for science education. Second, it uncovered how students expressed their

argumentative agency during participation in the dialogic and argumentative inquiry process. Finally, it explored some factors that affected the instructional framing of teachers towards implementation of classroom argumentation.

### **3.2. Defining a dialogic learning environment**

Dialogic talk originated from the Socratic approaches to dialogue: a dialectal process in which teachers and students share a joint inquiry into the learning process. Although generic principles underpinning the concept exist such as posing of genuine questions and transferring more of the responsibility of learning to the learners (Nystrand et al., 1997; Skidmore, 2000; Alexander, 2001, 2005), various aspects such as inquiry and pedagogy were targeted as potential areas to which dialogue can transform and impact the learning environment. Considering the contemporary works of Vygotsky, it may be useful to draw upon the works of Bakhtin (1982) who stressed that “the intrinsically dialogic nature of language is living, socio-ideological thing [which] lies on the borderline between oneself and the other” (1990, p. 293) adding that it was at its most potent in the form of speech. Moreover, as Wegerif et al. (2009) calls for dialogic education, inquiry process is seen not as teaching *through* but teaching *for* dialogue to become an end-in-itself with the aim not to reach complete agreement, or to construct knowledge, but for speakers “to be more open to other voices, more able to question and to listen and so more able to allow new unanticipated meanings to emerge” (p.185).

Dialogic inquiry posits that inquiry process considers the multiplicity of perspectives present in any response to include the many succeeding responses that may arise because of it. In responding to others, individuals cannot avoid bringing in prior knowledge which is shared from social and cultural factors which is so related to the ZPD principle. As Daniels (2001) expresses,

*The nexus of social, cultural, historical influences takes us far beyond the image of the lone learner with the directive and determining*

*tutor. It provides a much-expanded view of the 'social' and the possibility of a dialectical conception of interaction within the ZPD (p. 67).*

According to Lefstein (2010), due to the varying perspectives brought in dialogic inquiry, critical argument can reach “competing understandings and further inquiry” (p. 7). Each speaker brings their own set of meanings, views, values, beliefs, and assumptions to the ‘back and forth’ of discussion. Thus, dialogic inquiry reflects each set of ‘prejudices’ back to each speaker, and, if ‘engaged’, participants can then consider a perspective beyond their own. This therefore brings consideration to Alexander’s typology who added descriptors to the conduct of dialogic inquiry: *critical*, where participants explore points of contention, and *meaningful*, in which the participants consider their ‘horizons of meaning’ in relation to others and thus develop new (rather than shared) understandings. It would then be essential to ensure that students work within their ZPD which clearly requires the teachers’ good understanding of their nature according to their development stages to formulate a ‘developmentally appropriate’ problem. It also requires an understanding of ways to ensure that pupils do not try to impose their position on others or agree uncritically to preserve harmony.

Exploring various ways to improve students’ classroom engagement is obviously the central element of educational research in the recent years. In as much as the dynamics of dialogue is included in increasing students’ active involvement, dialogic interaction and its practical application need to be explicated. According to Alexander (2001), dialogic teaching occurs when the teacher and students establish a coherent thinking and conceptual understanding through continuous interaction. Moreover, it is characterized by the teacher’s use of authentic questions without pre-determined students’ answers but rather develops into a series of dialogic response that leads to a deeper course of interaction (Nystrand et al., 1997). In the process, students are encouraged to voice out their opinions, consider counterarguments of their peers, and attempt to establish a



compromise between others' perspectives and of their own. This happens because as students interact, they share individual sociocultural values, prior knowledge, and pre-conceptions about the topic that are sustained with increasing levels of reasoning when teachers continue to formulate higher-level questions for deeper understanding. As such, this study was therefore important as it explicated the students' expressions of argumentative agency that require them of some roles as active agents in the collaborative argumentation process given enough dialogic scaffolding.

Proficiency in science is equated to one's ability to formulate and assess scientific evidence as well as confidently participate in productive scientific discourse activities (Duschl, Schweingruber, & Shouse, 2007). Thus, integrating argumentation can play a major role in developing students' skills in scientific discourse aside from providing support in learning science content (Zohar & Nemet, 2002) and in helping them develop epistemological notions about science (Kuhn, Kenyon, & Reiser, 2006). Moreover, teachers' role in providing thought-provoking statements prompts students to participate in classroom discussions especially when they are required to provide justifications to their conclusions. It simply means dialogic scaffolding which sustains the continuity of students' oral expressions of their chains of thoughts so that they remain active through follow-up questions, elicited elaborations, and confirmations (Rasku-Puttonen et al., 2012). As students respond, their roles in the classroom discourse are shifted from being listeners and receivers of information to active agents in the knowledge construction. This study is therefore necessary as it tried to understand the impact of the teachers' knowledge and beliefs on argumentation in their dialogic scaffolding. Moreover, the study was informative as to how much cognizant the teachers are on their dialogic scaffolding and the extent to which they were able to elicit responses.

The large-scale prevalence of recitational patterns of talk in the classroom especially for low-achieving students was exposed in the major work of Nystrand et al. (1997), the ‘Opening Dialogue.’ In his work, he emphasized the differences of monologic discourse which often focused on transmission of knowledge and dominated by a recitation script and *dialogic instruction* which was focused on collaborative construction of knowledge through participation in dialogic exchanges. Dialogic instruction is thus often paralleled to a discussion where teachers’ statements are not preemptive to answers but possess the ability to take up and build upon ideas coming from students’ varying perspectives. The use of learning journals and peer-response conferences were just few of the classroom strategies that promote dialogic learning. Aside from the use of authentic questions, incorporating students’ responses into subsequent questions were known to deepen discourse atmospheres in the class.

In a sound learning environment, there exists reciprocity of ideas among the learners who “construct the ecology of social and cognitive relations in which the influence between any and all parties is mutual, simultaneous, and continuous” (Erickson, 1996, p. 33). The interactions occur in a dialogic manner that exhibit fair play of discourse using questions, verifications, and elaborations from the teacher and extended answers from the students such that they support each other’s social and cognitive learning processes. Moreover, the teacher’s questions and elaborations are used as scaffolds that elicit students’ responses based on their prior knowledge so that they capture their attention to focus on the main points for enhanced and expanded reasoning skills (Muhonen et al., 2016). Thus, this study recommends that there should be a dialogic negotiation in the classroom that occurs in an orchestrated social process in which both the teacher and students are open to the exchange ideas with detailed explanations.

### **3.3. Scaffolding in science education**

The concept of scaffolding was based on Vygotsky's Sociocultural Theory (SCT) emphasizing the importance of social interaction in learning and development. The term scaffolding was not explicitly coined by Vygotsky, but this was later formalized from understanding students' enhanced abilities to do tasks with the help of others (Muhonen et al., 2016). In science education, it is viewed as a form of assistance where learners are led to accomplish a task to develop their competence. Viewing it as a support however, brings about the misconception for its similarity to the pre-Piagetian way of adult-driven teaching and learning process. Nonetheless, as operationalized by Wood, Bruner, and Rose (1976) from Vygotsky's concept of teaching in the zone of proximal development (ZPD), scaffolding emphasizes a collaborative interaction between the teacher and the learner in the co-construction of their knowledge and skills.

van de Pol, Volman, and Beishuizen, (2010) identified three key characteristics of scaffolding: (a) contingency, (b) fading, and (c) transfer of responsibility. These characteristics are said to be interrelated with each other such that the teacher-learner interactions determine how these characteristics are exemplified. For instance, the sustainability of contingency, which is a form of response and tailored adaptation to students' understanding (van de Pol, Volman, & Beishuizen, 2010), sets the duration of support until fading is demonstrated to finally transfer the responsibility to the students. Moreover, based on the historical accounts on how scaffolding was used in science education, Pea (2004) identified "fading" as its key component. The essence of fading is that the impact of scaffolding is gradual and can be manifested once the learner is already proficient and is ready to do the task independently. While fading is the feature of scaffolding that distinguishes it from other forms of cognitive support, teacher-initiated inquiry is the most important component in the learning process in the classroom.

According to Emig and McDonald (2014), the presence of a person who does the scaffolding to a novice is not always required. One method of doing this is problematizing and structuring science content (Reiser, 2004). Problematizing is making a situation in need of a resolution and structuring is leading students to achieve a task by providing stepwise solutions (Emig & McDonald, 2014). Structuring and problematizing therefore can be task-oriented scaffolding strategies which draw students' attention and action to their assigned tasks. With the aim of science education to demystify the notion that science is a mere collection of facts but rather a social endeavor, students need to be provided with a learning environment where they can participate in and develop an understanding that one significant part of doing science is presenting claims with enough evidences. Thus, in an argumentative classroom, this task-oriented scaffolding can be implemented with enough support from the part of the teacher.

In this study, analyses of classroom transcripts were mainly focused on the contingency and fading phases of the classroom discussions. Focusing on the teachers' dialogic scaffolding of students' argumentative agencies in the contingency and fading phases, this study presented that classroom argumentation can be a venue where students are situated in a learning environment in a threaded discursive communication with the contingent role of the teacher to dynamically assess their responses. Moreover, as students are engaged in autonomous dialogic interactions during the fading phases, they were given enough opportunities to extend their dialogic interactions in their iterative reflections of well-defined or complex problems. These threaded responses are critical in both the contingency and fading phases because students' dialogic responses are primarily dependent on the teachers' dialogic prompts which will determine their accomplishments of similar argumentative tasks in the future. Moreover, the initial students' responses would determine the direction of utterances and structural moves as they practice their argumentative agency to investigate the claims, seek for evidences that would

justify the claims, and present rebuttal statements.

### **3.4. Argumentative agency in the current research**

The focus for argumentative agency in this study was inspired by the studies conducted regarding epistemic agency. Since it has been positively associated to students' qualities which build their personal initiatives to learn such as purposiveness, freedom, and creativity, argumentative agency in this study was coined to refer to the willingness of students to participate in the argumentative discussions. However, as discussions involved the flow of reasons from one person to another either from teacher to students or from one student to another, argumentative agency was applied to the collective efforts of establishing the links of discourse with classroom argumentation. Moreover, the presence of a mentor in the classroom, in this case, the teacher was proposed to provide the initiative to start the discussion that would develop into flexible turn-taking discursive interactions that will gradually lead to consensus. Moreover, to avoid the emergence of personal competing dialogues, the teacher was expected to mediate at any time during the discussion in an intersubjective or dynamic assessment to establish a culture of negotiation which centers on construction and co-construction of knowledge. Expressing of divergent ideas are however not sacrificed when responses were raised with counterarguments related to the current discussions that will encourage multiple perspective to surface as dialogic scaffolds for others to express their argumentative agency.

Thus in this research, argumentative agency was closely related to epistemic agency. It concerns the development of students' cognitions which were associated to the guidance in the provision of opportunities for the development of their collective and cognitive responsibility which has been identified as the core principle of knowledge building and advancement (Scardamalia & Bereiter, 2006). This is with the goal of building a mutual responsibility for setting learning goals between the teachers and the students (van Aalst & Chan, 2007).

The promotion of students' epistemic agency has been primarily associated with attempts to engage them as active agents in knowledge construction (Engle & Conant, 2002; Paavola & Hakkarainen, 2005). These attempts include restructuring the focus of instructional activities from the reproduction of knowledge, understanding the concepts and principles to accurate use of procedures (Greeno & Engeström, 2014). Epistemic agency can be fostered in a classroom of inquiry that is focused on the collaborative knowledge construction mentioned in the study of Muukkonen, Lakkala, and Hakkarainen, (2005) and meaningful science learning where teachers support the trajectory of emerging students' perspectives. In this study they claim that students' epistemic agencies are developed as they formulate explanation-seeking questions in a progressive inquiry manner.

In the last decades, the concept of epistemic agency has become very popular in educational research, practice, and policy discourses (Eteläpelto et al., 2013; Matusov, von Duyke, & Kayumova, 2015). Previous research has proposed that epistemic agency revolves around responsible participation and intentional membership in pedagogical practices that position students as actors and authors of their own learning (Brown & Renshaw, 2006; Kumpulainen & Lipponen, 2010; Greeno, 2006). Others associated agency to the dispositions to interpret, act on, and expand objects of activity (Edwards & D'Arcy, 2004). Still others consider those actions inclined to the initiatives to participate and eventually impact social practices (Virkkunen, 2006).

In an attempt to support the curricular reforms, the development of students' epistemic agency has been focused in previous research highlighting their involvement in building and monitoring the development of their own knowledge (Damşa et al., 2010; Stroupe, 2014). In the process, students are involved in identifying and deciding on how to pursue investigations in collaboration with peers or their teacher to achieve consensus from the products of their actions

(Edelson, 2001; Reiser, Novak, & McGill, 2017). As a result, the learning environment is established in coherence with students' perspectives as to why they are doing what they are doing with enough guidance from the teacher (Reiser, Novak, & McGill, 2017).

Supporting the development of students' epistemic agency requires significant shifts on the teachers' instructional goals and practices (Wilson, 2013) particularly in prioritizing either the depth or content of the science knowledge associated in every learning task (Reiser, Novak, & McGill, 2017). Often, the shifts or reframing of instructional goals increase the instructional challenges of teachers such as being unable to predict the responses of their students that would lead to anticipate the establishment of coherence of student-student interactions (Manz & Suárez, 2018; Richards et al., 2015). Ko and Krist (2019) suggest that these challenges which they call as tensions between how to support students' epistemic agency and standard-based curriculum can be seen as integral part of decision-making process regarding the instructional practices of teachers rather than treating them as mutually exclusive so that intentional reflections can be done to redistribute epistemic agency in teaching science.

According to Stroupe (2014), negotiation on what counts to be called as cognitive authority which influences students' experiences over time is necessary. In his study, he found out that classroom teachers who practiced and implemented ambitious instruction involved the students in collective negotiations so that their arguments were given cognitive authority and together, they "engaged in the conceptual, epistemic, social, and material aspects of science work in which over time, the classroom community advanced their collective understanding of science" (p. 507). The success of negotiation and establishment of cognitive authority can also be determined by the social contexts when students set the atmosphere for social relations in the classroom (Kawasaki, DeLiema, & Sandoval, 2014).

### **3.5. Developing students' epistemic agency for classroom argumentation**

In the study of Scardamalia and Bereiter (2006), they were able to propose the knowledge-building communities model (KBC) where students were tasked to solve authentic problems via face-to-face and online discourse. In a similar study conducted by Lai and Campbell (2018), they utilized the KBC model to support the development of secondary school students' epistemic agency in a knowledge-building discussion in the process of identifying knowledge gaps and mutual development of ideas. Results of this study showed that the Knowledge Forum, a computer-supported learning environment facilitated the students' knowledge-building discourse. In the process, students were assigned responsibilities for knowledge building actions enabled by social and physical structures. Moreover, thinking in the light of feedback from peers, students shared understanding of scientific knowledge rather than individually memorizing facts and repeating or confirming previously established information (Miller et al., 2018).

Stroupe (2014) conducted a multiple case study of five beginning teachers' classrooms framed into a *science practice community* using the science, technology, society (STS) and the history and philosophy of science (HPS) as teachers and students negotiate knowledge construction. Using the STS and HPS, the study examined how the teachers and students negotiated their roles as epistemic agents in science practice communities; in particular instructional routines and discursive moves. Results showed that framing science classes in either STS or HPS influenced how teachers and students participated in science practice communities and negotiated their roles in deciding on "what counts as science" and making science a "public or private enterprise" (Stroupe, 2014, p. 488).

In the ethnographic study of Sharma (2008), it was found out that students negotiated their roles and expressed their epistemic agency in selective appropriation whereby topics related to their experiential knowledge on electricity



lessons yielded active participation. Moreover, they were able to relate and communicate their out-of-school knowledge of electricity as they took initiatives to influence the direction of classroom dialogues. Thus, the study recommended the integration of students' experiences to serve as an opportune circumstance where they would exercise epistemic agency in a dialogically-mediated classroom environment. Thus, much as literature on argumentation heavily relies on its structural components, this study focused on the nature of dialogic scaffolding practices of teachers in both the contingency and fading phases that led to knowledge construction that can be conceptually and argumentatively negotiated.

In developing appropriate instructional strategies, teachers should be keen to consider both argumentation questions and the specific student outcomes to target the specific classroom context for scientific argumentation (McNeill & Knight, 2013). Specifically, teachers should provide students with an opportunity to justify and critique claims with evidences and reasoning strategies to enhance students' conceptual understanding. Research results suggested some instructional strategies to support the integration of argumentation into science learning. In the study of Gonzalez-Howard, McNeill, and Ruttan (2015), they concluded that teachers could engage students in argument through evidence by using three strategies: discussing the meaning of the word or phrase related to argumentation, doing a think-aloud to model the appropriate use of language during a task, and simplifying a complex claim by identifying key concepts. Moreover, it was also recommended that encouraging students to consider a counter-argument through questioning such as "Can anyone think of anything that somebody might say to oppose that? What might someone say which makes that argument a bit flawed?" can be appropriate argumentation questions to come up with active classroom participation. Integrating small tasks to promote students' use of argumentation such as concept cartoons to give a situation (Cavegnetto, 2010), competing theories (Osborne, Erduran, & Simon, 2004), making an analogy (Crippen, 2012) or using

anomalies (Roychoudhury & Rice, 2010), providing second hand data (Berland & McNeill, 2010), and utilizing discrepant events (Sampson & Clark, 2009) were also just few of the tasks that can promote students' use of argumentation.

Teachers' open-ended questioning strategies have been known to support dialogic interactions and were typical instructional practices to promote students' metacognitive skills (Berland & Reiser, 2009; McNeill & Pimentel, 2010). Moreover, small group discussions were supported through jigsaw activities (Jiménez-Aleixandre & Pereiro-Muñoz, 2005; Osborne, Simon et al., 2013; Sadler, 2006), hands-on activities (Roth & Garnier, 2007), or think-share-pair activities (Choi, Klein, & Hershberger, 2015) which were also promising strategies towards argumentative classroom settings. There was also an attempt to integrate video-based exercises focusing on the use of arguments to develop teachers' knowledge of argument structure and provide the examples of good and bad arguments (Osborne, et al., 2013). Moreover, research focused on scaffolding writing process by giving structured support or writing frame to explain a claim, evidence, and reasoning (Choi, Klein, & Hershberger, 2015; McNeil et al., 2006; Simon, Erduran, & Osborne, 2006) as well as modeling how to provide evidence and reasoning to support the claim (Choi, Klein, & Hershberger, 2015; McNeil et al., 2006) through writing or speaking were also conducted.

### **3.6. Advantages of classroom argumentation**

With emphasis on knowledge construction, the dialogic process which is regarded as the social aspect of argumentation is where individuals construct knowledge by interacting with each other such as learning a task together, listening to alternative ideas, engaging in critique, and building on each other's ideas (Alexander, 2005; Jimenez-Aleixandre & Erduran, 2008). This study aligns with Ford (2012) who addressed the idea that learners should be engaged similarly with scientists wherein social negotiation is involved in their conduct of experiment or investigation to make evidence-based explanations about a scientific problem and

discuss the alternative ideas with the goal of enhancing the objectivity, making revisions, and together, building consensus about their scientific claims. It was further presented that as learners engage in this practice, they become accustomed into the social and material aspects of science to construct knowledge of content and develop critical reasoning and literacy skills as they develop accountability in communication. Therefore, science teachers are highly encouraged to develop the knowledge of student conceptions with the appropriate pedagogical strategies to promote student-centered instruction that support students' engagement in scientific argumentation.

### **3.7. Developing teachers' PCK for classroom argumentation teaching**

Previous ideas hold the necessity for teachers' instructional framing focusing on classroom argumentation. Continuous and intensive professional development programs may support teacher learning to improve their knowledge and practice regarding argumentation (Desimone, 2009). Engaging teachers on workshops may enhance their knowledge of student conceptions and instructional strategies for argumentation particularly on analyzing student work, sharing their analysis for discussion, and reflecting on their implementation of argumentation. In the knowledge-for-action approach, McNeill and Knight (2013) examined the improvement of teachers' PCK of argumentation through research and evaluation systematically.

In this fifteen-hour workshop series, teachers developed strong understanding of evidence, claim, and reasoning components to evaluate students' writing, but the translation of this knowledge into classroom practice was challenging, particularly for the reasoning component. Instead of focusing on how to support students in stating their claims with evidences, teachers were found out to focus their attention on students' understanding of the science content. It was therefore concluded that teachers' lack of PCK of argumentation influenced the

design of their task and development of an argumentation question. Therefore, they suggested that teachers should have extended participation to professional development programs to provide them with enough exposure in designing educative curriculum materials to support their teaching through argumentation and translate their knowledge into classroom instruction.

In a recent study conducted by McNeill and colleagues (2016), the enactment of educative curriculum materials and how they influenced teachers' decision making to support students' learning around scientific argumentation was examined. Ten in-service teachers teaching either fifth or sixth-grade science who enacted two different six-week unit lessons were observed. Data included lesson artifacts, video-recordings, and teacher interviews and results showed that participating teachers had different understandings of argumentation and demonstrated these in their classroom instruction through their curricular choices based on their prior experiences. Two cases, representing high-quality and low-quality argumentation instructions to discuss the factors influencing teachers' decision-making around the enactment of curriculum materials were presented. The high-quality argumentation instruction addressed teacher's keen understanding of argumentation as an epistemic practice aligned with the curriculum materials. In this case, the teacher approached the prior teaching experiences as problematic, reflected in the enactment of the curriculum materials rather than following the instructions verbatim. Moreover, the teacher used questioning strategies to provide opportunities for students to evaluate the validity of multiple claims and understanding of the science content. On the other hand, low-quality argumentation instruction occurred when the teacher focused on surface-level features of argumentation and did not integrate the social construction of knowledge claims through critique and evaluation.

The objective of designing these educative curriculum materials was to support teachers' learning in argumentation instruction and understand how their interaction with those curriculum materials could improve their PCK of argumentation and enactment procedures. In the recent study of Marco-Bujosa and colleagues (2017), they utilized the sense-making framework to explore how teachers' use of educative curriculum materials supported their argumentation instruction and the development of their PCK of argumentation. Data were obtained from video-recordings of five middle school teachers, interviews, and pre- and post- PCK of argumentation assessments. Based on the findings, teachers had different learning outcomes from the same educative curriculum materials due to the differences in their goals which served as the determinant factor for their enactment coupled with their differences on their knowledge of argument structure and dialogic processes. To illustrate, teachers with high-alignment in enactment implemented argument-based curriculum materials and demonstrated higher learning gains parallel to their PCK of argumentation and that they rarely modified, skipped curriculum activities, or added new activities. On the other hand, teachers, who had low-alignment in the enactment, adapted but modified and skipped significant argument-focused activities on the curriculum materials. It was also observed that while one teacher indicated improvement in her PCK of argumentation by using the curriculum materials which supported her learning about argumentation, another teacher's use of curriculum materials did not support her learning about argumentation.

### **3.8. The secondary school science education in the K to 12 curriculum of the Philippines**

Through the Republic Act 10533, otherwise known as the Enhanced Basic Education Act of 2013 (Official Gazette of the Republic of the Philippines, n.d.) which was passed and signed into law by the former President Benigno S. Aquino Jr., the Philippine government institutionalized the K to 12 curriculum which added

a two-year senior high school from the former ten-year basic education system comprised of kindergarten, six years of elementary, and four years of high school. With the addition of two years for senior high school, the primary purpose of the K to 12 curriculum is aligning the Philippine educational system with its neighboring ASEAN and the global standards and competencies. Thus, the curriculum envisions the provision of every learner to be equipped with the necessary skills and competencies for the 21<sup>st</sup> century to become holistic with a strong recognition on the value of life-long learning.

Science education curriculum in the Philippines is mainly supervised by the Department of Education (DepEd). Its place in the Basic Education Curriculum starts from Grade 3 to Senior High School with the spiraling concepts that are distributed among the four general science fields namely: Biology, Chemistry, Earth Science, and Physics, each of these is covered within a quarter (three months) in the four-quarter academic year in the Philippines. In the spiral progression, the science concepts, which are integrated rather than discipline-based, increase in their levels of complexity from one grade to another which favors deeper understanding as well as applications of thinking skills in real life (K to 12 Curriculum Guide Science). The Biology component is specifically named as 'Living Things and their Environment and is divided into four themes: Parts and Function, Heredity: Inheritance and Variation, Biodiversity and Evolution, and Ecosystems (K to 12 Curriculum Guide Science). It promotes learner-centeredness with the spiraling science concepts expected to be implemented through varied inquiry-based teaching and learning approaches.

Alongside with the existence of the various types of secondary school in the Philippines is the presence of different curricula. The General Public High Schools (GPHS) implement the new K to 12 curriculum and they are supervised by the Department of Education (DepEd). Moreover, with the existence of the Republic Act 7678 of the Philippine government, the DepEd through its Bureau of

Secondary Schools, implement the Special Science Classes (SSCs) to enrich the curriculum in Science, Technology, and Mathematics through its Science, Technology and Engineering (STE) Program—formerly known as the Engineering and Science Education Program (ESEP). The STE-implementing high schools were identified by the DepEd who, alongside with general science curriculum, are expected to implement the STE curriculum in each grade level. They are particularly tapped to create at least two sections in each grade level which cater the needs of STE-inclined students for deeper learning environment centered on science, mathematics, and engineering.

On the other hand, the Department of Science and Technology (DOST), through its Philippine Science High School System (PSHS) implements its own secondary science curriculum which is focused on developing and empowering students to pursue STEM careers in the future. This curriculum is however, aligned to the K to 12 curriculum but with longer time of implementation and additional science subject areas which are added as elective courses to the general science classes in each grade level. One classroom of each curriculum type was observed and represented one case in the four classroom scenarios in this study (Table 1).

### **3.9. Improving the constructivist teaching approaches of science teachers in the Philippines**

Even before the implementation of the new K to 12 curriculum in the Philippine basic education, teacher professional developments (TPD) have been an essential component in both the pre-service and in-service teacher education. These TPD programs aim to develop the constructivist beliefs of teachers and to enhance their responsiveness to the various components that make up their career life as teachers such as curricular reforms which are adaptive to the globalization of education and diverse students' learning needs and cultural backgrounds. The enactment of these TPD programs aligns to Darling-Hammond's (1997) claim which says that teacher knowledge of subject matter, student learning and

development, and teaching methods make up the elements of effective teaching.

The first effort to improve the status of science education in the Philippines was the Science Teaching Project conducted by the Ford Foundation in 1964 which resulted to the creation of the Curriculum Development Center in the University of the Philippines (UP), later named as the Science Teaching Center (STC) in 1964, Science Education Center (UP SEC) in 1967, and currently the University of the Philippines National Institute for Science and Mathematics Education Development (UP NISMED). In the later 1980s, through the Australian AID's (AusAID) Philippine-Australia Science and Mathematics Education Project (PASMEP), teacher trainings were focused on understanding the teaching and learning process with a greater focus on lesson planning, improvisation of hands-on classroom activities, and laboratory activities which are connected to students' daily lives (Takamatsu, 2013). In 1997, a five-year massive teacher reform effort for was implemented nationwide through the Philippine-Australia Project in Basic Education (PROBE) with the aim to improve the basic education literacy in subjects such as English, mathematics, and science at the primary and lower secondary levels. Using the "action learning" (p. 38) model, six hundred teacher leaders, principals, and senior regional administrators were trained in Australia who later returned to the Philippines with lesson strategies based on the principles of constructivism (Beasley & Butler, 2002).

In another project named as Science and Mathematics Education Manpower Development Project (SMEMDP) implemented by the Japan International Cooperation Agency (JICA), teacher training implemented a top-down practical work approach which focused on understanding the importance of science activities in science classes. With the aim to decentralize and localize the teacher training aid projects in the country, JICA's School-based Training Program for Elementary and Secondary Science Mathematics Teachers (SBTP) was launched in 2002 to 2005 followed by three AusAID Projects namely Philippine-



Australia Project in Basic Education (PROBE), Philippine-Australia Basic Assistance for Mindanao (BEAM) from 2002 to 2010, and the Strengthening Basic Education in the Visayas (STRIVE) in 2005 to 2009. All these previous aid projects were implemented with the aim to promote inquiry-based teaching and learning rather than the transmissive-based teaching strategies (Takamatsu, 2013).

Currently, through the UP NISMED's Collaborative Lesson Research and Development (CLRD) Project which revolves around the concept of the Japanese "lesson study," in-service science teacher trainings in the Philippines are focused on appreciating the value of inquiry-based teaching, planning and implementing a school-based inquiry-based lessons, reflection and post-lesson discussions. These projects primarily recognized the importance of collaboration of in-service teachers and science education experts in planning, implementing, and reflecting on inquiry-based lessons using evidences for students' responses (Gutierrez & Kim, 2017). In a previous study, this classroom-based PD on inquiry teaching and learning yielded three positive outcomes for teachers' development of constructivist beliefs namely: 1) increased understanding of classroom dynamics; 2) shared ownership and involvement; and 3) reflective practice to connect and resolve ideas against prior beliefs (Gutierrez & Kim, 2017, pp. 444-445).

## **Chapter 4. Methodology**

### **4.1. Research design**

This study primarily utilized the qualitative multiple case study design for the thematic analysis on the knowledge and belief systems affecting teachers' dialogic scaffolding for their students' expressions of argumentative agency in classroom argumentation. As hypothesized that the teachers' knowledge and beliefs on the nature of teaching and learning and the nature and advantages of classroom argumentation influenced their framing of instructional approaches towards implementation, these were explored and analyzed in order to explain the differences on their dialogic scaffolding practices to implement classroom argumentation in both the contingency and fading phases. Thus through thematic analyses, the dialogic scaffolding practices of the teachers were identified and how they implemented these in their classrooms was explained. Moreover, since dialogue involves a two-way process, the students' expressions of argumentative agency as a response to their teachers' dialogic scaffolding in both the contingency and fading phases were thematically analyzed. To visualize the chains of utterances of the students' as a product of their expressions of argumentative agency, argumentative maps were constructed from the contingency and fading phases of the lesson transcripts.

It is important to note that much as scaffolding is composed of three phases namely contingency or dynamic assessment, fading or providing just the right amount, and transfer of responsibility, the study was just focused on the contingency and fading phases in an attempt to understand the teacher-student interactions in the contingency phase and the students-students interactions as a response to the teachers' dialogic prompt in the fading phases.

According to Merriam (2010), a qualitative research usually starts with assumptions, worldviews, or theoretical lenses which explain the meaning of what the participants will bring into a social problem. A case study is one of the

approaches in a qualitative research wherein a researcher analyzes a bounded system or a multiple bounded system called *cases* in their natural settings without explicit control or manipulation of variables. Through the “unit of analysis,” case studies differ from other qualitative approaches such as ethnography, phenomenology, and narrative research. A single or multiple case for individuals, groups, or events represent the case with specific properties unique to them and are different from other cases. Depending on the presence or absence of subunits, a case study could be categorized as embedded (with subunits) and holistic (no subunits) (Yin, 2014). This study can therefore be categorized as multiple holistic case study design which focused on four multiple cases, each case representing a unique context but share common characteristics in the broader bounded system.

In this study, since each teacher had different characteristics in terms of their knowledge and belief systems, a thematic analysis was conducted on the effects of these on their dialogic scaffolding practices for students’ expressions of their argumentative agencies in the contingency phases. Moreover, due to the variation of classroom characteristics in the classes which were observed in the study, the qualitative research design employed a thematic multiple case study. In this study, the four teachers involved implemented two approaches to argumentation in their biology classes: Teacher Loida and Teacher Carlo implemented SSI-based argumentation; Teacher Don and Teacher Mara implemented content-based (biology) argumentation. Analysis on the differences of these instructional approaches was conducted in relation to their dialogic scaffolding practices of the classroom discussions. Also, students’ responses to their teachers’ dialogic prompts were mapped based on the patterns and trajectories of their utterances.

Another factor that justifies the use of multiple case analyses in this study is the differences in the curriculum which guided the teachers’ implementation of their biology classes. Much as these curricula were implemented by two different

educational agencies in the Philippines, each teacher implemented different types making the study explore the implementation of classroom argumentation in four different curricula of the public school systems in the Philippines (Table 1). With the differences in the curriculum, different topics to which classroom argumentation was implemented, were explored in this study. It is also important to emphasize that while there were two types of DepEd curricula explored in this study, the GPHS curriculum represents the majority of high schools and the STE is a curriculum implemented by few appointed public schools in the country as a Special Science curriculum alongside their major implementation of the GPHS curriculum. The DOST-PSHS curriculum is a Special Science curriculum implemented by the education council of the Department of Science and Technology (DOST).

## **4.2. Sampling and settings of the study**

The purposive sampling method was used in this study. According to Teddlie and Tashakkori (2009), purposive sampling is a dominant strategy in educational research which utilizes “particular settings, persons, or events and were deliberately selected for the important information they could provide that could not be gotten as well from the other choices” (p. 170). The selection of the samples is usually based on the purpose of inquiry, the theoretical orientation, and the existing gaps in knowledge that are needed to be addressed from the samples of study. As Ritchie and colleagues (2013) suggest, the locations are set based on salient features which are significant in addressing the context of inquiry. In this study, the purposive sampling technique was utilized to select participating schools which represented the various types of public school science curriculum in the Philippines.

This study was conducted in two different locations in the Philippines. The first site was in the National Capital Region where the Main Campus of the Philippine Science High School System was located. Despite the availability of

thirteen (13) campuses associated to this school, the main campus was purposively selected for proximity to the researcher. The second study site is a public high school in the Region II of the Philippines particularly in Tuguegarao City. It was also selected purposively due to the availability of the type of curriculum implemented in this school. It is considered as the biggest school in terms of population in the province of Cagayan, Region II.

The participating classes were also purposively selected considering the criteria for teacher selection and the time of the classes. For convenience of immediate data validation between the observers during the observation period, the classroom observations were set for two different time periods (one in the morning and one in the afternoon) for both DepEd and DOST schools. Another factor that was considered was the availability of the teacher for an informal dialogue with the researcher immediately after the classroom observation as this would help in the immediate consolidation of data from the observation notes of the two observers. Due to the purposive sampling that was employed, it was found out in the demographic data analyses that in both DepEd and DOST schools, the two classes that were selected were implementing two different curricula. This informed therefore the four classes which composed the multiple case analyses as the qualitative research design used in this study. Further, this led the study to explore one Regular Biology class and one Biology Elective from both DepEd and DOST curricula implemented in the Philippines.

Usually, in purposive sampling technique, the most appropriate cases were selected to represent the characteristics of the samples that would answer the research questions. Initially, this study followed this but after selecting the samples that fitted the criteria, initial demographic analysis informed the final research design that was used. It is however, important to emphasize that the generalizability of the results in this study can be constrained due to the small sample size and the presence of bias in the selection procedure. Therefore, since

generalizations for a larger population are not possible, claims are specific to the cases but the in-depth understanding of each case can represent a scenario that may be found in few other similar cases in Philippine science classes.

### **4.3. Participants of the study**

This study involved both teachers and students in their classroom settings to obtain significant amount of data for analysis. With a total of four teachers—each representing a case for the public schools curriculum from both DepEd and DOST, two male and two female teachers and their students were the focus of this multiple case study. These teachers were chosen with the following selection criteria: 1) must be teaching a general biology class in a public high school in the Philippines; 2) must have taught biology for the past five years; 3) must have a minimum knowledge of argumentation teaching through exposures in either seminar-workshops or trainings; and 4) must declare a voluntary participation after the researcher presented the goals of the study and the extent of their involvement in the study.

The sampling criteria that were set in this study inform three factors. As the study looked forward to informing some of the curriculum-related policies regarding the implementation of the K to 12 curriculum in the Philippines, the first criterion was set as this study was primarily focused on the public school curricula implemented in the Philippines. The second and third criteria were related to the PCK of the teachers involved. Because previous research claim that science teachers must develop their PCK for scientific inquiry to promote inquiry-based teaching and learning (Beyer, Delgado, Davis, & Krajcik, 2009; Davis & Krajcik, 2005; NRC, 2012b), teachers must possess constructivist beliefs, enough knowledge of biology content as well as knowledgeable on the nature and advantages of classroom argumentation. As Biology majors, it was assumed that teachers therefore possess the minimum knowledge in biology content required to teach the subject. Moreover, with the regular in-service teacher trainings conducted

by various educational institutions in the Philippines aligned to the implementation of the K to 12 curriculum since 2012, the teachers in this study were assumed to have minimum knowledge on the value of inquiry-based teaching which includes classroom argumentation in science education. This therefore complements their content knowledge in biology. Finally, the fourth criterion was related to the ethics observed in this study. Table 1 presents the demographic characteristics of the teachers who were selected and were qualified to participate in the study based on the set criteria.

Table 1. *Demographic Characteristics of the Teachers Involved in this Study*

Teachers	Highest Science/Science Education Degree	Years of Teaching Experience	No. of trainings in science inquiry/argumentation	Type of curriculum taught
<b>SSI-based classes</b>				
Case1: Teacher Loida	MA Biology Education	35	More than 20	STE – Science Elective (DepEd)
Case 2: Teacher Carlo	MA Environmental Education/ Master in Bioethics	8	More than 10	Special Science – Biology Elective (PSHS-DOST)
<b>Content-based classes</b>				
Case 3: Teacher Don	BS Education (Physics)	5	5	GPHS – Regular Biology (DepEd)
Case 4: Teacher Mara	MA Biology Education	11	9	Special Science – Regular Biology (PSHS-DOST)

As shown in Table 1, except for Teacher Loida, most of the teachers were early career teachers with more than five years of teaching experience but with significant number of exposures to various inquiry-based teaching approaches which included classroom argumentation. It can also be noted that one of the teachers (Teacher Don) is a physics major teaching a biology class. Despite of this,

he was still selected because he was the one who was qualified enough to fit in most of the criteria set in this study from among his colleagues teaching biology using the DepEd GPHS curriculum. During the analysis, it was found out that his case was significant enough in terms of the implications of this study. His case can be widely observed across most GPHS schools in the Philippines because of the spiraling progression of science concepts in the new curriculum. With the implementation of the K to 12 Basic Education curriculum in the Philippines, some of the science teachers such as Teacher Don must adapt to the spiraling progression and to the distribution of the four science subject areas in each grade levels. Thus, in his case, even though he is a Physics major, he was also expected to teach other general science subjects such as biology, earth science, and chemistry within the school year. For teachers who were biology majors, similar situations can be observed thus within the school year, they were also expected to teach not only biology but earth science, chemistry and physics.

In Grade 8 science, biology content area was placed in the fourth quarter to which the observation period of this study was conducted. Prior to selection, an orientation was conducted by the researcher and the criteria and consent for participation were presented. Assent forms were distributed to the teachers and they were asked to indicate their voluntary participation in this study. However, the student participation was dependent on the voluntary participation of their biology teacher. Despite of this, the researcher still conducted an orientation for the students to present the purpose, the method of data collection, and the degree of involvement of each student. It was clarified that since they belonged to the selected class of their teacher, they will automatically be involved if they signify their assent which was supplemented by their parents' or guardians' consent.



Table 2. *Grade Level and Gender Distribution of the Students in the Classes and the Focused-group Discussion*

Curriculum type	No. of students			Total
	Grade level	Males	Females	
<b>SSI-based classes</b>				
STE – Biology Elective	8	22	28	50
Special Science – Biology Elective	10	12	16	28
<b>Content-based classes</b>				
GPHS-Regular Biology	8	15	20	35
Special Science – Regular Biology	8	13	18	31
<b>Total</b>				<b>144</b>

#### 4.4. Classroom dynamics

This study was conducted during the fourth grading period of the DepEd schools and on the third grading period of the Philippine Science High School. This difference of implementation of the school year was due to the gradual shift of academic calendar in the Philippine schools in response to the ASEAN integration which is one of the rationale for the implementation of the K to 12 curriculum. To specify, this was an initial move for Philippine schools particularly the universities to synchronize their academic calendar with other ASEAN universities to increase mobility of faculty and students within the ASEAN region and the rest of the world. Prior to the enactment of the K to 12 curriculum into law, the academic calendar of Philippine schools from primary to tertiary levels was from June of the current year to March of the following year. Table 3 presents the classroom dynamics of the classes involved in this study together with their specific lesson units and the subtopics which were observed.

Table 3. *Classroom Dynamics of the Classes Observed in this Study*

<b>Curriculum type</b>	<b>Lesson Unit and Subtopics</b>	<b>Classroom Dynamics</b>
<b>SSI-based classes</b>		
STE – Biology Elective	<b>Unit:</b> Stem cell and cloning <b>Topics during observation:</b> Introduction to stem cells; Types of stem cells; Argumentation on stem cell research; cloning	<ul style="list-style-type: none"> <li>✓ Teacher checks the reading assignment</li> <li>✓ Teacher asks a student to recall the issue that they are to resolve in class related to their topic</li> <li>✓ Teacher presents and clarifies some scientific terms</li> <li>✓ Whole class or group discussion Presentation of the group discussion (whenever applicable) followed by whole class discussion after the group presentation (whenever applicable)</li> </ul>
Special Science – Biology Elective	<b>Unit:</b> Ethics <b>Topics during observation:</b> Ethical frameworks in human research; Consent for clinical trials; Ethics of quarantine; Genetic engineering in humans	<ul style="list-style-type: none"> <li>✓ Recall of the past lesson</li> <li>✓ Introduction of the lesson by the teacher</li> <li>✓ One student provides a background information about the topic (reporting)</li> <li>✓ Student-reporter provides argumentative statements</li> <li>✓ Teacher assess, rephrase, and simplify the argumentative statements</li> <li>✓ Whole class or group discussion about the topic</li> <li>✓ Presentation of the group discussion (whenever applicable) followed by whole class discussion after the group presentation (whenever applicable)</li> </ul>
<b>Content-based classes</b>		
GPHS- Regular Biology	<b>Unit:</b> Classification of living things <b>Topics during observation:</b> Classification of living things; Bacteria, Fungi, Protists	<ul style="list-style-type: none"> <li>✓ Recall of the previous topic</li> <li>✓ Teacher checks the assigned reading assignment by asking questions Presentation of the group discussion (whenever applicable) followed by whole class discussion after the group presentation (whenever applicable)</li> </ul>
Special Science – Regular Biology	<b>Unit:</b> Pattern of inheritance in humans <b>Topics during observation:</b> Introduction to pattern of inheritance; Autosomal dominant and recessive mode of inheritance (2 sessions); X- linked dominant and recessive mode of inheritance; Y-linked mode of inheritance	<ul style="list-style-type: none"> <li>✓ Recall of the previous topic</li> <li>✓ Teacher checks the assigned reading assignment by asking questions</li> <li>✓ Whole class or group discussion Presentation of the group discussion (whenever applicable) followed by whole class discussion after the group presentation (whenever applicable)</li> </ul>

As presented in Table 3, it can be noted that the teachers in the four classes usually started their discussions through a recall of their previous lessons and checking of the students' reading assignment. Based on the observation, it was noted that the teachers particularly emphasized that the students need to conduct a research on certain topics with guide questions used as prompts for them to make anticipated decisions and formulate arguments to be presented in class. At the start of the class, the teacher initiated the discussions by eliciting the reading and research outputs of the students to explore their background knowledge that would enrich the scientific information available for the class in preparation for their classroom argumentation. Moreover, the teachers provided significant time for group discussions prior to the whole class discussions which promoted individual participation. It can be noted that the biology elective subjects were both focused on socioscientific issues which supported classroom argumentation while the two regular biology classes were content-focused.

## **4.5. Data collection**

### **4.5.1. Procedure**

Qualitative multiple case study design involves collection of various forms of data in a single study. These data were combined to enhance the reliability and to ensure triangulation strategies (Teddlie & Tashakkori, 2009). Thus, qualitative data were obtained from various sources such as classroom observations, audio- and video recordings of classroom scenarios, interviews, and survey. Robust amount of data was from classroom observations, audio, and video recording of classes which were obtained for four weeks from the third week of January to the third week of February 2018. The researcher, together with another science teacher from both schools conducted non-participant observations for five sessions through field notes. While observing the classroom scenarios, audio- and video records were set up strategically in the classroom ensuring minimal distractions from the

natural classroom behaviors of both the teacher and the students. The observers also positioned themselves at the back of the classroom in a sitting position for the teacher and students not to be distracted. After each observation period, the two observers met together and consolidated their observation notes.

At the middle of the data collection phase and at the most convenient time of the teachers, the researcher conducted audio-recorded interviews through casual and informal conversations but with the use of interview guides. These were supplemented by the survey instruments in Likert format to assess their beliefs on teaching and learning and their knowledge and beliefs on classroom argumentation. All data sources were utilized to present a general profile of the teachers' knowledge and belief systems on the nature of teaching and learning and on classroom argumentation which affected their dialogic scaffolding practices for their students' expressions of argumentative agency.

Table 4. *Data Gathering Instruments Used for each Research Question*

<b>Research Questions</b>	<b>Data sources</b>
1. What were the teachers' dialogic scaffolding practices and how did they implement these for students' expressions of argumentative agency in both the contingency and fading phases of classroom argumentation?	<ul style="list-style-type: none"> <li>• Teacher's Dialogic Scaffolding on Argumentation Observation Checklist (TDSAOC)</li> <li>• Classroom Observations</li> <li>• (Transcripts of the audio- and video-recordings)</li> <li>• Field Notes</li> </ul>
2. What were the teachers' knowledge and belief levels on the nature of teaching and learning and on the nature and advantages of classroom argumentation which affected their framing of instructional approaches and their dialogic scaffolding practices and implementation strategies?	<ul style="list-style-type: none"> <li>• Teacher's Beliefs on Teaching and Learning Questionnaire (TBTLQ)</li> <li>• Teacher's Beliefs on Teaching and Learning Interview (TBTLI)</li> <li>• Teacher's Knowledge and Beliefs on Argumentation Survey (TKBAS)</li> <li>• Teacher's Support for Classroom Argumentation Interview Guide (TSCAIG)</li> </ul>
3. What argumentative agencies are expressed by the students in response to their teachers' dialogic scaffolding and how did these manifested in both the contingency and fading phases of classroom argumentation?	<ul style="list-style-type: none"> <li>• Classroom Observations (Transcripts of the audio- and video-recordings)</li> <li>• Field Notes</li> </ul>

#### 4.5.2. *Instruments*

Various instruments were used in the study to obtain both quantitative and qualitative data necessary to answer the research questions. Most of these instruments were adapted from literature and were slightly modified for the Philippine context. All these instruments were pilot-tested prior to data collection to ensure that they were contextually standardized for the general characteristics of the Filipino teachers and students in biology. Validity and reliability analyses were computed and presented in the following subsections.

**Survey questionnaires.** Two survey questionnaires were used to obtain the data which were used to understand the teachers' knowledge and belief systems which affected their dialogic scaffolding for classroom argumentation. The first instrument is the Teacher's Beliefs on Teaching and Learning Questionnaire (TBTLQ) adapted from Wooley, Benjamin, and Wooley (2004) and the second one is the Teacher's Knowledge and Beliefs on Argumentation Survey (TKBAS). The TBTLQ is a 27-item Likert instrument and was used to assess the teachers' beliefs on teaching and learning in science based on three aspects of their beliefs system namely: belief on classroom management, belief on the teaching process, and belief on how to interact with students' parents. On the other hand, the TKBAS is a 25-item researcher-constructed Likert survey with items categorized into any of the four components: 1) beliefs on the role of argumentation in science teaching and learning, 2) knowledge on the dialogic processes of argumentation, 3) beliefs on the students' argumentative abilities to engage in classroom argumentation, and 4) knowledge on the nature of classroom argumentation. Both instruments were composed of positive and negative statements which asked the teachers to indicate their level of agreement from *strongly disagree* to *strongly agree*. Ratings therefore yielded the highest on the *strongly agree* responses for the positive statements and on the *strongly disagree* for the negative statements. These instruments were pilot tested to 13 in-service science teachers and 12 pre-service science teachers for

reliability and validity analyses prior to actual data gathering and Table 5 shows the acceptable Cronbach's alpha values for each of their respective components.

Table 5. *Results of the Reliability and Validity Analyses for the TBTLQ and the TKBAS*

<b>Aspect of teacher's belief system on teaching and learning for the TBTLQ</b>	<b>Cronbach's alpha</b>
Classroom management	.732
Teaching process	.721
Interaction with students' parents	.710
<b>Components of the teachers' knowledge and belief system for classroom argumentation from the TKBAS</b>	
Belief on the role of argumentation science teaching and learning	.713
Knowledge on the dialogic process of argumentation	.709
Belief on the students' argumentative abilities	.724
Knowledge on the nature of classroom argumentation	.737

As literature establishes the role of teachers' constructivist beliefs in their provision of students' active involvement in the knowledge construction, data from the TBTLQ were used to understand their levels of constructivism which affected their dialogic scaffolding their students' argumentative agencies in classroom argumentation. Moreover, since classroom argumentation is one of the inquiry-based teaching strategies of a constructivist teacher, data from the TKBAS was used to supplement the data from the TBTLQ. In a case analysis, since there is a limitation on the sample size which leads to non-generalizability of results, in-depth analysis was done using "multiple sources of evidence, with data needing to converge in a triangulating fashion" (Yin 2009, p. 18) was ensured. Thus, the survey data obtained to understand the general profile of the teachers' knowledge and belief systems on the nature of teaching and learning and classroom argumentation which affected their dialogic scaffolding was triangulated using data transcripts from interview, audio- and video recordings, and observation guides. Sample copies of these instruments are found in Appendix IIIA and IIIB.

**Interview Guides.** For triangulation purposes mentioned earlier, the teachers were interviewed using two interview guides: Teacher's Beliefs on Teaching and Learning Interview (TBTLI) and the Teacher's Support for Classroom Argumentation Interview Guide (TSCAIG). TBTLI was adapted from Luft and Roehrig (2007) and this instrument was composed of seven (7) questions about teacher's beliefs on science teaching and learning while TSCAIG was a researcher-constructed interview guide composed of two broad questions with three to four sub-questions to prompt the teachers for elaborated responses on how they dialogically scaffold their students' expressions of argumentative agency. Pilot-testing results revealed that each interview session using these interview guides can be done within 40 to 60 minutes (Appendix IIIC and IIID).

**Observation Checklist.** During the classroom observation and the coding process, the Teacher's Dialogic Scaffolding on Argumentation Observation Checklist (TDSAOC) was used to obtain data on how the teachers' dialogic scaffolding practices for classroom argumentation were evident in their respective classes. This was a researcher-constructed observation guide from a priori categories from literature (Songer, Shah, & Fick, 2013; Hammond & Gibbons, 2005; Scott, 1998) and contained three types of dialogic prompts: conceptual, analytical, and reflective (Table 9). Each of this type of dialogic prompt contains two dialogic scaffolding activities of the teachers as their method of dialogically scaffolding the students' expressions of argumentative agency. In the conceptual dialogic prompts, teachers' dialogues gave hints and clarified terms from the students' responses. In the analytical dialogic prompts, teachers' dialogues directed students' responses to necessary science/biology content and presented argumentative prompts. Finally, reflective dialogic prompts were used to probe further the students' responses and enable them to do reflective thinking.

During the observation and coding processes, the observers counted the number of times these dialogic scaffolding prompts occurred in the classroom discussions. To strengthen the data obtained from this checklist, the researcher and the other observer wrote the evidences of occurrence for each of the dialogic prompts of the teachers. At instances during which some of dialogic scaffolding practices were not in the criteria, written notes were provided by the observers. To ensure immediate results, the two observers consolidated their observation guides and agreed upon the final outcome after every observed classroom session. The consolidated results of the observation guides were again counterchecked by the researcher when the audio and video transcripts were prepared. A sample copy of this instrument is found in Appendix III E.

**Lesson transcripts.** In order to identify the teachers' dialogic scaffolding practices and the students' expressions of argumentative agency, lesson transcripts from the audio- and video-recorded classroom implementations were iteratively coded, recoded, and analyzed using the constant comparison method of qualitative data analysis. Five lesson observations from each class were transcribed for a total of 20 lesson transcripts that were subjected to constant comparison which were later used for thematic analyses.

These transcripts were also used to determine how the teachers implemented their dialogic scaffolding practices and how the students expressed their argumentative agency as responses to their teachers. Coding of the transcripts focused on which type of dialogic scaffolding prompts the teachers displayed in their dialogic scaffolding practices and the roles of their dialogic scaffolding prompts that led to the students' expressions of argumentative agency. Moreover, coding for students' data was focused on the types of dialogic responses and the roles of their dialogues to extend the discussions.



## **4.6. Data analysis and interpretation**

In this study, the constant comparison method (Glaser, 1965) was used to develop the themes and subthemes from the coded data transcripts. The combination of the inductive and template coding approaches were used to constantly compare the a priori codes generated from literature and the data-driven codes. These codes were then merged to form the final codebooks that were utilized in the iterative coding. In the iterative coding, related codes were grouped together to make a synthesis and finally establish the themes that represented what and how the teachers implemented their dialogic scaffolding practices and strategies for students' expressions of argumentative agency in both the contingency and fading phases of their classroom argumentation. Similar process were conducted to formulate the themes which were identified to represent the students' expressions of their argumentative agency in response to their teachers' dialogic scaffolding practices in both the contingency and fading phases.

In the iterative thematic analyses, classroom transcripts were divided into segments based on either contingency and fading phases. Contingency phases are those segments where the teacher was deeply involved in the discussion. On the other hand, fading phases were these segments where at least five (5) utterances were shared following the teacher's initial dialogic prompt. Since the transcripts involved the whole class, some segments where students did not specify their voluntary participation were excluded in the analysis to ensure the ethicality of this research. Earlier works guided this study in gaining insights about the data collection procedures and analysis of results. In this method, analysis started with open coding (Corbin & Strauss, 2008) which included both the data and the theories that established the initial themes followed by iterative and constant analysis in the search for emergent codes and categories which explained the relationships of more specific categories.

#### ***4.6.1. Analysis and interpretation of the teachers' dialogic scaffolding practices and implementation strategies for students' expressions of argumentative agency in both the contingency and fading phases***

To identify what were the teachers' dialogic scaffolding practices and implementation strategies for students' expressions of argumentative agency in both the contingency and fading phases, thematic analyses were conducted on the transcripts of their audio- and video-recorded classes. As shown in Table 9, four themes represented their dialogic scaffolding practices in the contingency phases which were implemented using two different but related strategies and two themes were identified in the fading phases with four different implementing strategies. In both the contingency and fading phases, further analyses were conducted to explicate the relationship of their knowledge and beliefs on the nature of teaching and learning and on the nature and advantages of classroom argumentation to their framing of instructional approaches (i. e. SSI-based or content-based). These were then used to categorize and group their dialogic scaffolding practices and strategies in both the contingency and fading phases.

As mentioned earlier, three types of teachers' dialogic scaffolding prompts were generated from the iterative analysis of classroom transcripts (Table 6). These were further analyzed in terms of their functions to elicit students' responses. Supplemented with the data obtained during the classroom observation, frequency counts which were converted to percentages were graphed and tabulated to represent the types of dialogic prompts from the entire lesson transcripts. Sample coded classroom transcripts representing the different types of teachers' dialogic scaffolding practices in both the contingency and fading phases were included in the results section. Line-by-line presentation of the dialogic exchange was included to show the discussion flow which established the peer-to-peer interactions that occurred in their argumentative and dialogic inquiry.

Table 6. *Types of Teachers' Dialogic Scaffolding Prompts*

Type of dialogic prompts	Dialogic activities	Teacher's dialogue...
Conceptual ( <i>Conc</i> )	Orienting to hint ( <i>Or hint</i> )	<ul style="list-style-type: none"> <li>• provides background knowledge.</li> <li>• notifies the students to relate the topic to prior scientific knowledge.</li> </ul>
	Exploring prerequisite knowledge ( <i>Pre knowl</i> )	<ul style="list-style-type: none"> <li>• clarifies to the students their understanding of related terms to be used in the current context.</li> <li>• asks the students to contextually define scientific terms.</li> </ul>
Analytical ( <i>Ana</i> )	Generating ideas and explanations ( <i>Gen ideas and expl</i> )	<ul style="list-style-type: none"> <li>• clarifies the evidence based on scientific knowledge.</li> <li>• asks for explicit explanation of the scientific terms that the students used.</li> </ul>
	Presenting argumentative prompts ( <i>Pres arg prpts</i> )	<ul style="list-style-type: none"> <li>• presents an argumentative statement and challenges students to present their arguments or counterarguments.</li> </ul>
Reflective ( <i>Refl</i> )	Probing further( <i>Pro fur</i> )	<ul style="list-style-type: none"> <li>• asks for elaborations on students' arguments, counterarguments, and rebuttals</li> <li>• plays a "devil's advocate" to encourage counterarguments and rebuttals</li> <li>• asks for varied viewpoints to encourage further presentation of ideas.</li> </ul>
	Enabling reflective thinking ( <i>Ena refl thnkg</i> )	<ul style="list-style-type: none"> <li>• directs the students towards real-life connections.</li> <li>• presents statements or questions that invoke reflections from students.</li> </ul>

A priori coding (from literature) of the categories and codes were used to characterize the dialogic scaffolding roles of the teachers in both the contingency and fading phases in their classroom discussions. To understand this, sample coded classroom transcripts were also presented based on the roles presented in Table 7. Line-by-line descriptions of the peer-to-peer interactions were also included at the end of each sample transcript in order to understand how the dialogic prompts of the teachers elicited responses and encouraged students to express their argumentative agencies.

Table 7. *Teachers' Various Dialogic Roles for Dialogic Scaffolding in Classroom Argumentation*

<b>*Dialogic scaffolding roles (contingency phase) and codes used</b>	<b>Explanation of the actions</b>
<i>The teacher acts to...</i>	
Link statements to prior experience ( <i>Link pri exp</i> )	<ul style="list-style-type: none"> <li>• Giving emphasis to students' prior experiences</li> </ul>
Recapitulate ( <i>Recap</i> )	<ul style="list-style-type: none"> <li>• Recapping most important learning points</li> </ul>
Appropriate( <i>App</i> )	<ul style="list-style-type: none"> <li>• Appropriating students' contributions (words, ideas, information) into the lesson discourse</li> </ul>
Recast ( <i>Recast</i> )	<ul style="list-style-type: none"> <li>• Recasting students' wordings to match ideas appropriate for discourse</li> </ul>
Cued elicit ( <i>Cued eli</i> )	<ul style="list-style-type: none"> <li>• Offering verbal or gestural hints about expected responses</li> </ul>
Increase perspective ( <i>Increa pers</i> )	<ul style="list-style-type: none"> <li>• Handing back responsibility to students to continue discussion</li> </ul>
<b>Dialogic scaffolding roles (fading phase)</b>	
Being a support ( <i>Supp</i> )	<ul style="list-style-type: none"> <li>• Sustains the discussion by adding information or acknowledging the science behind students' statements.</li> </ul>
Being a tool for communication to exist in class ( <i>Tool comm</i> )	<ul style="list-style-type: none"> <li>• Provides prompts rather than evaluation that may be useful to extend the discussion.</li> </ul>
Being an extension of the students' capacities ( <i>Ext cap</i> )	<ul style="list-style-type: none"> <li>• Transfers the responsibility of providing answers to questions to other students.</li> </ul>

*\*Adapted from Hammond and Gibbons (2005, p. 21).*

#### **4.6.2. Descriptive analysis on the teachers' knowledge and belief systems on the nature of teaching and learning and on the nature and advantages of classroom argumentation**

To present the general profile of the teachers' knowledge and belief systems on the nature of teaching and learning, their responses on the six-level Likert scale (from strongly disagree to disagree) of the TBTLQ were assigned a sub-category

from slightly traditional to highly constructivist. Subcategories were then merged into three to present a summary of the teachers' beliefs on the nature of teaching and learning. The final categories were traditional (highly traditional, traditional), transitional (slightly traditional, slightly constructivist), and constructivist (constructivist, highly constructivist). Since the number of items comprising the knowledge and belief systems in the TBTLQ was not equal, frequency counts of response data were converted into percentages and graphically presented. Moreover, each of the teachers' belief and knowledge systems based on the components of the TBTLQ were tabulated (Table 12). Verbatim responses from the interview were also presented in the results section to strengthen the evidences for the claims regarding the varying levels of teachers' beliefs on the nature of teaching and learning.

One of the criteria for selection of teacher-participants was their exposure to classroom argumentation as a teaching strategy in science classrooms mainly from direct experiences through formal and informal education, seminars, workshops, or conferences. Using the survey data from the TKBAS, their Likert responses were assigned with values ranging from 1 (strongly disagree) to 5 (for the strongly agree). Since this instrument was composed of both positive and negative statements, scores were reverse transformed for the negative statements; in this case, negative statements had the *highest score* for the *strongly disagree* and *lowest score* for the *strongly agree*. Moreover, since the number of items was not equally distributed, the percentage scores in each component were calculated and the general profile of the teachers' knowledge and beliefs on classroom argumentation were tabulated and graphed. Presentation and analysis of results were supplemented by their verbatim responses obtained from the informal interview using the TDSPIG and the TSCAIG.

Merging the data obtained from the survey and interview with the iterative coding and recoding of classroom transcripts, the varying levels of teachers' knowledge and beliefs on the nature of teaching and learning and classroom

argumentation were analyzed to formulate themes for their dialogic scaffolding of students' expressions of argumentative agency in both the contingency and fading phases (Table 9). For instance, a teacher with a constructivist view on the nature of teaching and learning and who is informed on the nature and processes of argumentation would frame his/her instructional practices towards classroom argumentation and would implement dialogic teaching to elicit students' argumentative agency in presenting evidence-based arguments for their claims. This hypothesis was obtained from previous findings claiming that teaching argumentation requires teachers' understanding of their students, the unexpected events in the classroom, and enough knowledge and understanding of integrating argumentation in their classroom practice (Zemba-Saul, 2009; Evagorou & Dillon, 2011).

In the cases of Teacher Don and Teacher Mara, their constructivist views, though with varying levels and their knowledge and beliefs on classroom argumentation influenced their decisions to implement argumentative discussions and eventually, the differences of their dialogic scaffolding practices in both the contingency and fading phases. Also, Teacher Loida's and Teacher Carlo's constructivist and informed views on classroom argumentation influenced their personal decisions to implement classroom argumentation resulting to their SSI-based approaches in their Biology Elective classes but with different practices of dialogic scaffolding in the contingency and fading phases of their classes.

#### ***4.6.3. Analysis and interpretation what and how the students' expressed their argumentative agency as a response to their teachers' dialogic scaffolding practices in both the contingency and fading phases***

Similar classroom transcripts were analyzed to identify what and how the students' expressed their argumentative agencies as responses to their teachers' dialogic scaffolding practices in both the contingency and fading phases of their classroom argumentation. In the iterative coding and recoding of the transcripts, the

roles of the students' dialogues were separately coded in both the contingency and fading phases and themes were formulated in order to identify the expressions of their argumentative agency. This were however, understood as responses to their teachers' dialogic scaffolding practices thus, themes and subthemes were aligned to the dialogic scaffolding practices of the teachers to establish the dynamic interplay of their interactions. After the iterative analysis of the codes, four themes unique to each class and aligned to their teachers' dialogic scaffolding practices and strategies were formulated for both the contingency and fading phases (Table 10).

As co-constructors and epistemic agents in the dialogic exchange of knowledge construction, the students' roles which indicated their expressions of argumentative agency were also identified. Based on Table 8, students' roles can be classified as either constructive or critic. Constructive roles included their dialogues which made them reason out and support each other. Critic roles, on the other hand, are roles which made them challenge, clarify, and evaluate each other's dialogues during their argumentative discussions. As the students were provided with more autonomy in the discussion, these roles were mostly found in the fading phases and were dependent on the first dialogic response of any student to their teachers' dialogic prompts. Sample coded transcripts from each case were also presented and the line-by-line interactions were discussed to understand how the dialogic prompts of the teachers led to the students' varied expressions of argumentative agency.

Table 8. *Coding Scheme for the Students' Dialogic Argumentative Roles*

Categories of Students' Argumentative Agency	Students' argumentative roles	Descriptive characteristics	Sample statements
Constructive	Reasoner <i>(Reas)</i>	Students present their reasons or justifications on their ideas	<ul style="list-style-type: none"> <li>• <i>I think it's definitely this... it says in here that it's possible to...</i></li> </ul>
	Support <i>(Supp)</i>	Students build each other's arguments by backing up or modifying each other's statements	<ul style="list-style-type: none"> <li>• <i>I think he is right...it also says in here that...</i></li> </ul>
	Challenger <i>(Chall)</i>	Students question each other with reference to a data presented to them or to their existing knowledge as a product of their research	<ul style="list-style-type: none"> <li>• <i>No, because if you look at it...</i></li> <li>• <i>...but it says that...</i></li> <li>• <i>Does your data support that?</i></li> </ul>
Critique	Clarifier <i>(Cla)</i>	Students elicit the meaning or elucidate the ideas that were previously presented	<ul style="list-style-type: none"> <li>• <i>But is there a chance that we don't inherit the disease?</i></li> <li>•</li> </ul>
	Evaluator <i>(Eval)</i>	Students evaluate other students' ideas for their strengths and weaknesses	<ul style="list-style-type: none"> <li>• <i>I think it is autosomal dominant...</i></li> <li>• <i>Well it says in here that X-linked traits are...</i></li> <li>• <i>But your table presents ___ which is not supposed to be there</i></li> </ul>

To further understand the dynamic interplay of the teacher's and students' dialogic interactions, sample transcripts were mapped in order to explicate the patterns and trajectories of utterances based on the types of dialogic responses which were used by the students as expressions of their argumentative agency. These maps were determined by the chains of reasons and the type of dialogic roles expressed (either constructive or critic). Two argumentative maps: simple and complex were researcher-made based on the iterative coding and recoding of the



classroom transcripts. As argumentative mapping is mostly concerned with the chains of utterances, student-student dialogues were mostly considered which were usually found in the fading phases. In the maps, the position of arrowheads indicated which ideas were prompted from the previous chains and which ideas the newly-expressed ones were addressed to as expressions of either constructive (support and reasoning out) or critic (clarify, challenge, evaluate) dialogic roles.

Simple argumentative maps were characterized as either linear or constructive which means that the chains of utterances were supportive of each other, thus arrowheads were all pointing to one direction indicative of support. Simple argumentative maps were usually constructed from the transcripts of the content-based classes as their discussions were mostly conceptual in nature. However, these were also found in the SSI-based classes when the dialogic exchange was focused on building the scientific concepts behind the issues that they were trying to resolve. The complex argumentative maps were either complex conceptual or complex multi-inferenced. These were constructed based on the nature of responses that were shared in the fading phases of dialogic interactions. The complex conceptual maps which were mostly constructed from the content-based classes were characterized by students' multiple ideas expressed in both the constructive and critic students' dialogic roles. Their arguments contained primarily conceptual knowledge in the form of either factual or canonical. On the other hand, complex multi-inferenced maps which were usually constructed from the SSI-based classes involved chains of reasons expressing both the constructive and critic dialogic roles with arguments focused on students' varying inferences or opinions.

#### **4.7. Establishing the research quality**

An integrated framework comprised of credibility, transferability, dependability, and confirmability can be incorporated together to establish the quality of a research (Teddlie & Tashakkori, 2009). Synonymous to the internal validity, the credibility of the research deals with the plausibility of the research findings as well as the capacity of the research to uncover the complexity of human behavior, to present a holistic interpretation of the phenomenon of interest, and to finally understand the perspectives of those involved (Merriam, 2009). In this study, multiple data were obtained using different methods and were used in the analysis to establish the research claims. One-on-one teacher interviews and survey questionnaires were used to establish the teacher's profile about their beliefs on teaching and learning and their knowledge and beliefs on the nature and advantages of classroom argumentation. It was hypothesized that these beliefs should be manifested in their actual classrooms and these were assessed using the classroom observation guides indicative of their dialogic scaffolding practices for students' expressions of argumentative agency. Moreover, the iterative analysis on the classroom transcripts established a confirmation on the teachers' beliefs and dialogic scaffolding practices.

Similar to external validity, transferability refers to the generalizability of the findings to similar settings. To ensure this, Teddlie and Tashakkori (2009) suggested that the research must provide enough data which are descriptive of the setting and the participants involved in the cases. This research obtained a robust data to where the rich description of the cases was presented to enhance its transferability. Moreover, dependability, which is analogous to reliability, is concerned with the extent of the design of the study as well as the research methods to examine whether the different processes were reasonable enough to provide consistent conclusions (Teddlie & Tashakkori, 2009). Furthermore, all the survey questionnaires which were mostly adapted, modified, and contextualized

were subjected to pilot testing, reliability, and validity analyses.

Confirmability concerns the “objectivity of the study and determined how the interpretations are supported by the results and are internally coherent” (Teddlie & Tashakkori, 2009, p. 295). Thus, in this study, each method of data collection was matched to which types of data were collected for triangulation purposes. The emergence of bias and predetermined assumptions was also minimized through the different types of data that were used to analyze the consistency of results. Moreover, the thematic analyses coincided with each research question and how the data were analyzed and interpreted.

According to Hoepfl (1997), confirmability can be established in the form of “raw data, analysis notes, reconstruction and synthesis products, process notes, personal notes, and preliminary developmental information” (p. 14). To ensure objectivity, the themes, categories, codes, and fragments of the classroom transcripts that were utilized during the constant comparison method of analysis were presented to experts for validation purposes. Verbatim quotes which supported the iterative coding that was conducted as well as sample line-numbered lesson transcripts were included in the presentation of results to establish evidences that match the final outcome of the coding process.

#### **4.8. Ethical considerations**

Besides establishing valid claims to answer the research questions, ethical quality was observed to establish the well-being of both the teacher and student participants. Prior to the data gathering, the approval of the Seoul National University Institutional Review Board (SNUIRB) was sought (Appendix II). The background information, the data gathering procedure, the data analyses, and interpretation procedures were summarized and presented for evaluation and approval of the SNUIRB who conducted regular reviews, determined the appropriateness of the research project, and ensured the welfare of the research participants (Teddlie & Tashakkori, 2009) using their approved consent forms

(Appendix II). Approvals from authority lines before coming to the school were sought using a request letter which was noted and signed by the researcher's dissertation adviser (Appendix I).

Prior to the data gathering, the researcher presented the context of the study and the extent of participation of the teachers and students to the heads of the schools and after ensuring voluntary participation, consent and assent forms were distributed, signed, collected, and kept. The consent forms ensured the privacy of all participants to establish anonymity and confidentiality (Teddlie & Tashakkori, 2009). Confidentiality was ensured and participants were informed of the researchers' exclusive access of their data and that pseudonyms will be assigned to them during data analysis. Moreover, it was also emphasized for both teachers and students that withdrawal from participation was allowed anytime; thus all data obtained from them will not be included during data analysis. A declaration on the length of data storage time before data are completely discarded was also indicated in the consent forms. To lessen invasion to the natural setting of the classrooms, cameras were strategically placed in locations where students and teachers were not distracted in the class. Moreover, the observers positioned themselves in an area of the classroom where teachers' and students' behavior and learning processes in their natural setting were not disturbed.

## Chapter 5. Results and Discussion

General results showed that each of the four teachers had unique dialogic scaffolding practices for students' expressions of argumentative agency in both the contingency and fading phases of classroom argumentation implementation. In the contingency phase, four themes represented their dialogic scaffolding practices and each of them had two different but related strategies to implement these dialogic scaffolding practices (Table 9). It was also observed that their dialogic scaffolding practices were associated to the type of instructional approaches (e. i. SSI-based or content-based) they used to implement classroom argumentation.

On the other hand, two themes associated to their framing of instructional approaches, represented their dialogic scaffolding practices in the fading phase. Despite similarities in the dialogic scaffolding practices associated to their framing of instructional approaches, each of the teachers in the SSI-based and content-based classes had their own ways of implementing those dialogic scaffolding practices. It is however important to note that the teachers had lesser dialogic scaffolding practices in the fading phases as this phase was the time when they gave their students autonomy to discuss among themselves and to express their argumentative agency thus, they gradually lessened their dialogic prompts. Moreover, analysis showed that the varied teachers' dialogic scaffolding practices were related to their knowledge and beliefs on the nature of teaching and learning and on the nature and advantages of classroom argumentation.

This chapter is divided into three parts. The first part presents the dialogic scaffolding practices of the teachers in both the contingency and fading phases. The second part is the presentation of their characteristics in terms of their knowledge and beliefs on the nature of teaching and learning and on the nature and advantages of classroom argumentation. The last part presents the two methods of students' expressions of their argumentative agency, each corresponding to the contingency and fading phases. These were also immediately followed by how they collectively,

as a whole class, were able to express these argumentative agencies in both the contingency and fading phases. Moreover, their expressions of argumentative agency were supplemented by argumentative maps which showed the patterns and trajectories of their chains of reasons as responses to their teachers' dialogic scaffolding prompts and which showed expressions of their dialogic roles as either constructive or critic while expressing the argumentative agency.

Table 9. *Themes and Sub-themes for the Teachers' Dialogic Scaffolding Practices and Implementation Strategies in the Contingency and Fading Phases*

<b>Teachers' dialogic scaffolding practices in the <i>contingency phase</i></b>	
<b>Instructional approach</b>	<b>Teachers' dialogic scaffolding practices and implementation strategies in the <i>contingency phases</i></b>
SSI-based classes	<b>Theme 1: Appropriation strategies</b>
	Subtheme 1: <ul style="list-style-type: none"> <li>Using prior scientific knowledge to build abstract concepts from simple ones</li> </ul>
	Subtheme 2: <ul style="list-style-type: none"> <li>Providing scenarios that may be experienced by the students</li> </ul>
	<b>Theme 2: Enactment of the culture of negotiation</b>
	Subtheme 1: <ul style="list-style-type: none"> <li>Offering neutral points of view as prerequisites for integrative negotiation</li> </ul>
	Subtheme 2: <ul style="list-style-type: none"> <li>Converging disparate ideas leading to collective consensus</li> </ul>
Content-based classes	<b>Theme 1: Conceptual-reflective questioning strategies</b>
	Subtheme 1: <ul style="list-style-type: none"> <li>Questioning using factual-canonical concepts</li> </ul>
	Subtheme 2: <ul style="list-style-type: none"> <li>Extending discussion through reflective inquiry</li> </ul>
	<b>Theme 2: Flexible affirmations of students' ideas for collective consensus</b>
	Subtheme 1: <ul style="list-style-type: none"> <li>Providing reinforcement for a mutually contingent dialogic exercise</li> </ul>
	Subtheme 2: <ul style="list-style-type: none"> <li>Revoicing to increase students' backing and enhance their discursive identity</li> </ul>
<b>Teachers' dialogic scaffolding practices and implementation strategies in the <i>fading phase</i></b>	
SSI-based class	<b>Theme 1: Recognition on the students' scientific knowledge capitals</b>
	Subtheme 1: <ul style="list-style-type: none"> <li>Recontextualization of the classroom dynamics</li> </ul>
	Subtheme 2: <ul style="list-style-type: none"> <li>Power distribution of discursive ideas</li> </ul>
Content-based classes	<b>Theme 2: Sensitivity to students' willingness to participate in the dialogic exchange</b>
	Subtheme 1: <ul style="list-style-type: none"> <li>Responsiveness to and raising of students' scientific cognitive demands</li> </ul>
	Subtheme 2: <ul style="list-style-type: none"> <li>Provision for gradual autonomy for learner uptake of the dialogic prompts</li> </ul>

Being dialogic in nature, students' expressions of argumentative agency were also related to their teachers' dialogic scaffolding practices and strategies in both the contingency and fading phases. Each class had one collective method of expressing their argumentative agency in the contingency phases encompassing of the two related strategies of their teacher's dialogic scaffolding. Thus, four themes represented the methods of students' expressions of argumentative agency in the contingency phase (Table 10). For the fading phase, there was a one-to-one correspondence on the teachers' dialogic scaffolding strategies and students' expressions of argumentative agency; thus, four themes also represented the students' expressions of argumentative agency in the fading phases (Table 10).

Table 10. *Themes and Sub-themes for the Students' Expressions of Argumentative Agency as Responses to Teachers' Dialogic Scaffolding Strategies in the Contingency and Fading Phases*

<b>Scaffolding phases</b>	<b>Students' expressions of argumentative agency</b>
<b>Contingency phases</b>	
SSI-based classes	<ul style="list-style-type: none"> <li>• Sharing of personal experiences which serve as contingent dialogic prompts to both the teacher and peers</li> <li>• Two-sided stances responses which further elicited peer-to-peer interactions</li> </ul>
Content-based classes	<ul style="list-style-type: none"> <li>• Combined conceptual and reflective responses in the dialogic inquiry</li> <li>• Positive recognition of teacher's reinforcements through gradual increase of unsolicited responses</li> </ul>
<b>Fading phases</b>	
SSI-based classes	<p><b>Neutral and immediate application of scientific knowledge in the dialogic responses in the contingency phase</b></p> <ul style="list-style-type: none"> <li>• Immediate application of the lesson concepts to their daily lives</li> <li>• Recognition of the importance of turn-taking in the dialogic exchange</li> </ul>
Content-based classes	<p><b>Use of science concepts, willingness take part and recognition the advantages of turn-taking in the fading phases</b></p> <ul style="list-style-type: none"> <li>• Recognition and more use of scientific concepts</li> <li>• Willingness to take the responsibility to respond to personal and/or peer inquiry</li> </ul>

## **5.1. Teachers' dialogic scaffolding practices**

The enactment of classroom argumentation in this study was focused on the oral discussions that were dialogically scaffolded by the teachers which elicited the students' expressions of their argumentative agency. Results showed that the teachers' knowledge and belief systems influenced their framing of instructional approaches for their implementation of classroom argumentation which eventually affected their dialogic scaffolding practices and strategies for implementation. These were observed in both the contingency and fading phases for each of their five lessons that were observed. Based on their levels of knowledge and belief systems, they were able to frame their instructional approaches for classroom argumentation towards either SSI-based or content-based which resulted to their unique dialogic scaffolding practices. Their dialogic scaffolding practices were presented through themes followed by subthemes for their implementation strategies, each with corresponding lesson transcripts to show the enactment of these practices. Line-by-line discussions of the interactions in the sample lesson transcripts were presented in order to show how the roles of their dialogic scaffolding prompts which supported and elicited the students' responses for the expressions of their argumentative agency with either constructive or critic roles.

### **5.1.1. Dialogic scaffolding practices and implementation strategies in the contingency phases**

*SSI-based implementing teachers.* As mentioned, there were four different dialogic scaffolding practices that were implemented by the teachers in the contingency phase and these were associated to their framing of instructional approaches for classroom argumentation implementation. In the SSI-based classes, Teacher Loida used appropriation strategies and she used two different but related strategies to implement her appropriation strategies: 1) using prior scientific knowledge to build abstract concepts from simple ones, and 2) providing scenarios



that may be experienced by the students. On the other hand, Teacher Carlo was able to initiate a culture of negotiation by: 1) offering neutral points view as prerequisites for integrative negotiation, and 2) converging disparate ideas for collective consensus in his dialogic prompts.

### ***Theme 1: Appropriation strategies***

There has been an increasing emphasis on supporting students to engage in classroom argumentation in their science classes. Discussions in classroom argumentation come in different ways such as formal and informal debates, small group discussions, think-pair-share activities, or whole class discussions with the goal of involving students to communicate with each other through speaking and listening. In Teacher Loida's class, whole class dialogic discussion for classroom argumentation was used and she successfully scaffolded her students in order to elicit their responses and in the process, they were able to express their argumentative agency with either constructive or critic dialogic roles. In order to sustain the discussions, Teacher Loida used the appropriation strategies. The appropriation strategy of Teacher Loida was characterized by allocating the significant positions of the students' thoughts by using their prior knowledge and experiences to initiate discursive interactions. In the process, she paid close attention to her students' chains of reasoning and through contingent dialogic prompts, she recapped or recapitulated their ideas in order to place them in the discussion plane. As she continuously executed this, students realized that their ideas were all contributory to the sustenance and continuous flow of dialogic exchange in their discussions.

The dialogic appropriation strategies of Teacher Loida in the contingency phases were usually through the use of initial phrases such as, "Ok, you said that..." "You mentioned about...", "I agree/disagree with...what if...", "what do you mean by..." Through these statements, students were invited to share more of their insights which served as elaborations to their previous claims. At times, other

students were prompted to support others' claims when they felt they were knowledgeable enough to express similar and support arguments. It was noted that when their discussions were focused on reflections on the applications of their current lessons, the chains of reasons were dominated with critic roles as they deliberately challenged, critiqued, or evaluated previous responses. It can therefore be inferred that through the appropriation strategies of Teacher Loida, students developed their self-regulation to organize their thoughts in order to participate in the discussions as expressions of their argumentative agency. For example, in Line 7 in Transcript 1, Teacher Loida used the phrase, "what do you mean by..." to appropriate Grace' response. As such, Grace was prompted to give an example using a prior knowledge about 'Dolly, the sheep' to explain her claim. The discussion continued using this example which resulted to their formulation of the formal and scientific definition of cloning.

It can also be noted in Line 7 that Teacher Loida appropriated the initial response using a local knowledge through the use of the term 'Xerox.' However, with Grace having the prior knowledge about Dolly, the cloned sheep, Teacher Loida's use of the simple concept to appropriate the discursive interaction was immediately shifted to a more scientific and abstract one. Same scenario happened to the line of discussion starting from Line 25. Prior to the discussion Albert mentioned about DNA and this was properly appropriated by Teacher Loida. In the transcript, it can be noticed that Albert' mention of the concept of DNA made the discussion gradually shift from the use of layman's terms to more scientific words. Recognizing the prior knowledge of the students, she tried to appropriate their ideas through their responses about the anatomy of the cell. Thus in Line 25, she formulated an analytical question which implied that she was signaling the students to relate the DNA of a cloned sheep to the extraction of the nucleus in the cloning process. As such she introduced the term surrogate, to which she supplemented it with a definition.

It can be noticed in Line 28 to 36 that through her appropriation strategies of using students' prior knowledge on the anatomy of the cell, her dialogic prompts led them to reconcile which DNA is closely similar to the DNA of the cloned sheep. In the chain of discussions, the final and concrete answer with exact explanation were all from Karen in Line 34 and 36 through her appropriation strategies of asking further explanations for her claims. As the discussion continued, she initiated to apply the new knowledge by relating it to a social knowledge which can be directly or possibly experienced by the female students in class. She tried to elicit their decisions whether in the future, they would be agreeing to undergo in-vitro-fertilization (IVF) when they will be encountering problems about pregnancy in their marriage lives. Because of this reflective dialogic prompt, both male and female students became reactive to express their argumentative agency. Using local knowledge about the successful IVF procedure of a famous personality in their country, they were able to reconcile their personal decisions about the issue.

The continuation of this discussion can be found in Transcript 2. In this transcript, their discussion went on to resolve the issue whether a cloned individual is normal or not. As she continuously appropriated the students' responses as in Line 9 of Renan's answer, she tried to draw out his justification of what he meant as 'alien' when he associated this to a cloned individual. Still appropriating the students' use of local knowledge, she was successful in facilitating them to resolve the normality of an in-vitro-fertilized person by recapping and putting emphasis on the students' use of 'Scarlet Belo,' the daughter of a famous celebrity medical doctor in the Philippines as an example depicting the normality of a successful in-vitro-fertilized individual.

Based on these two transcripts, through Teacher Loida's appropriation strategies in dialogic scaffolding, the students were able to develop self-regulated learning by keeping themselves motivated to express their argumentative agency in the discussions. Their motivations can be attributed to the continued chains of

responses with activated their cognitions using their everyday and prior scientific knowledge as foundations to the development of concrete scientific terms. As such, they responded to Teacher Loida's dialogic prompts with more elaborations of their claims and justifications. Moreover, through the appropriation strategies of Teacher Loida, the collaborative knowledge construction became student-initiated as most of the factual and canonical terms were scientifically defined and all came from them through their collective and interrelated dialogic responses.

*Using prior scientific knowledge to build abstract concepts from simple ones.* It is a general knowledge that scientific terms are difficult to comprehend. Since terms are not associated to everyday language, it is difficult to grasp their meanings when used or heard for the first time. In fact, this was one of the reasons why the science topics in the Philippine K to 12 curriculum are spiraling in an increasing complexity from one grade level to another. Moreover, different science subject areas were strategically placed in the curriculum from one grading period to another in every grade level so that scientific terms from earlier grading periods will be used as prerequisite knowledge to succeeding ones. Nevertheless, with the complexity of science terms, there still exist gaps in understanding among students. Therefore, it is important to dialogically scaffold the development of understanding and meaning making of these terms in class. In Teacher Loida's class, this was properly addressed through her appropriation strategies as a dialogic scaffolding practice. As such, she usually used prior scientific knowledge to build abstract concepts. Through this, she was successful in initiating a dialogic exchange so that students were able to relate on what she was trying to imply. As she used layman's terms at the start of the conversations, students responded with deductive reasoning and used the simple knowledge to form complex ideas.

In the following fragment of their lesson transcript on cloning (Transcript 1), Teacher Loida started the discussion with a conceptual dialogue particularly the 'orienting to hint' when she made a brief recall of their previous lesson on stem

cells and linked it with their current lesson on cloning (Line 4). Raizel responded with an example using the ‘Dolly’ the cloned sheep which was followed by a rough definition from Grace. Using these two responses, she appropriated their responses by increasing their perspectives and asking them the question, “*What do you mean by making a copy of yourself?*” to clarify their statements. It was implied that this was her way to set the discursive atmosphere using simple concepts which later developed into abstract ones. Moreover, in the dialogic responses below, Teacher Loida used words that were familiar to students like the term ‘Xerox copy’ in Line 7 to appropriate the previous response from Grace. Appropriating using simple and familiar concept set their discussion into an active-participatory dialogic environment providing venue for the students’ expressions of their argumentative agency.

As the discussion went on, Teacher Loida elicited more ideas from the students by offering them verbal hints and asking them to read from their notes (Lines 19 to 20). Acknowledging the information provided from the reading of notes, she started the classroom argumentation by prompting the students with an analytical dialogue and asking them for their claims about the DNA of the newly-developed lamb. It can also be noted that in order to increase students’ familiarity with the terms, she provided a simple definition of the word ‘surrogate,’ waited for few seconds for the responses and then provided another dialogic prompt (Lines 25 to 27). After few seconds of waiting for responses, she noticed that students were challenged to express their opinions which signaled her to increase the available information about the nuclei of the donor and the surrogate mother during the cloning process (Lines 28 to 29). This prompted Chris (Line 30) to express his undecided claim that the DNA of the newly-developed lamb was from the surrogate. This was obviously not the expected answer but instead of providing an evaluative prompt, Teacher Loida encouraged Chris to explain his argument. Listening to Chris’ explanation in Line 32, she increased the students’ expressions

of argumentative agency by eliciting more answers (Line 31) and explanations (Line 35) to the right answer from Karen. This dialogic interaction progressed into the combination of conceptual and reflective discussion from Lines 58 to 71.

Transcript 1. *Fragment of the Classroom Transcript on Lesson 'Cloning' (Lesson 4, 17-01-2018)*

Speaker	Dialogic interactions
1	<b>Teacher:</b> Ok, yesterday, we discussed about stem cells. And related to this is the topic on cloning. So
2	I remember I told you to read on this so we can have a good discussion today! I will be able
3	to know who read something through the discussion today! Alright, what come to your
4	mind when you hear the word cloning? Yes, Raizel! ( <b>Conc; Prio exp</b> )
5	Raizel: Ma'am, Dolly, the cloned sheep!
6	Grace: Ma'am making a clone of yourself! Like a copy of yourself!
7	<b>Teacher:</b> What do you mean by making a copy of yourself? Do you mean like a Xerox copy of
8	yourself, Grace? ( <b>Conc; Increa pers</b> )
9	Grace: Ma'am, making an exact copy of yourself! Like Dolly...
15	<b>Teacher:</b> Ok, if you read about cloning, you might have encountered the two types of cloning and
16	one is the way how Dolly the sheep was cloned. Who read that?..Who knows? What are the
17	two types of cloning? Anyone? Yes, Gil! ( <b>Conc; Cued eli</b> )
18	Gil: Ma'am reproductive cloning and molecular cloning!
19	<b>Teacher:</b> Anyone who read about reproductive cloning? About how it is being done! You can read
20	what you have there! Yes, Albert! ( <b>Conc; Cued eli</b> )
25	<b>Teacher:</b> Ok, very good Albert! Now I have a question, to which DNA is the newly developed lamb
26	similar to? The nucleus donor or the surrogate? Surrogate means where the blastocyst was
27	implanted. What is your opinion? ( <i>No answer after 28 seconds of waiting</i> ) ( <b>Ana; Increa pers</b> )
28	<b>Teacher:</b> Ok, take note that the nucleus was taken from another egg cell...then after developing into
29	a blastocyst, it was implanted into another sheep...so which DNA is the new lamb similar
30	to? ( <b>Conc; Prio exp</b> )
30	Chris: Ma'am, maybe the surrogate!
31	<b>Teacher:</b> Why Chris? Explain... ( <i>Waits for few seconds</i> )...I want to listen to your explanation. ( <b>Ana; Increa pers</b> )
32	Chris: Ma'am, coz the new egg had the food from the surrogate...
33	<b>Teacher:</b> Ok, any more opinion? Who says from the donor? Yes Karen! ( <b>Ana; Increa pers</b> )
34	Karen: Ma'am from the donor coz they take the nucleus of the cell!
35	<b>Teacher:</b> Why what is in the nucleus? ( <b>Conc; Increa pers</b> )
36	Karen: Ma'am the nucleus contains the genetic information or the DNA!
58	<b>Teacher:</b> Ok, good reason! But I will tell you a scenario. What if you are married and you want to
59	have your own children and you cannot undergo normal pregnancy. But you still have egg
60	cells because you can still undergo menstruation. Would you like to take your egg cell and
61	implant it into another woman with the sperm of your husband to have your own baby? ( <b>Refl; Increa pers</b> )
62	Gina: Ma'am like Belo! Scarlet Belo was IVF!
63	<b>Teacher:</b> Ok taking that as an example. They have the means. They have money! Don't you want
64	that? ( <b>Refl; Cued eli</b> )
64	Claire: Ma'am it's still not normal!
65	<b>Teacher:</b> Ok, any more opinion? ( <b>Ana; Increa pers</b> )
66	Dianne: Ma'am for me it's ok since they became happy after that! And Scarlet Belo is normal! So
67	maybe it's ok!
68	Dina: Good for them that Scarlet Belo became normal! What if she was not normal, they spent a
69	lot, and their baby is not normal!
70	Rem: Of course you have to make sure that your baby is normal! They have money so they will
71	take care of the surrogate mother!

*Providing scenarios that may be experienced by the students.* This appropriation method is directly related to the first method. Using scenarios which can be or possibly be experienced by the students, they were able to respond with confidence; thus increasing their expressions of the argumentative agency. This can also be similar to everyday or cultural knowledge that everyone was familiar with. As such, hesitance to express responses was minimized. With varying cultural or religious backgrounds in the case of the Filipino students, multiple perspectives were brought to the discussions which served as scaffolds not only to other students but to the teacher as well to formulate more open-ended and reflective contingent dialogues.

Based on the second half of the Sample Lesson Transcript 1, Teacher Loida started her contingent dialogic scaffolding by providing the students with a scenario which was linked to the concept of in-vitro fertilization (Lines 58 to 61). From the transcript above, it can be noticed that the students were already familiar with the concept so that the discussion was immediately switched to abstract terms based on response of Gina (Line 62). Recasting Gina's response, she increased the argumentative issue by providing information that elicited students' decisions ("*They have the means. They have money*"). However, the response was a firm opposition from Claire when she said that doing the process is "*not normal.*" To encourage more responses, she prompted others to express more of their opinions and Dianne' expressed agreement to the IVF procedure in the future with a slight elaboration and opposition to Gina's response (Line 66 to 67). However, this was challenged by Dina when she expressed her opinion of the possibility of having an abnormal baby (Line 68). Using evidences from the information given by Teacher Loida when she set the argumentative scenario ("*They have money*"), Rem expressed her counterargument to Dina and supported Dianne for their agreement on the in-vitro fertilization (Lines 70 to 71).

As their discussion on cloning continued, the argumentative discussion became deeper and integrated as they utilized all the previous concepts from the peer-to-peer cross talk. In the following classroom transcript, Teacher Loida's initial analytical dialogic prompt elicited the students to express their decisions on the issue regarding whether 'a cloned individual is a normal individual or not.'

Transcript 2. *Fragment of the Classroom Transcript on Lesson 'Cloning' (Lesson 4, 17-01-2018)*

Speaker	Dialogic interactions
1 Teacher:	Now my question is, are cloned individuals considered normal individuals? Yes
2	Ryan! ( <b>Ana; Cued eli</b> )
3 Ryan:	Yes Ma'am! Look at Scarlet Belo! She is very normal and very smart!
4 Dianne:	They are normal! Coz we said before that only the nucleus are taken! And the
5	blastocyst is not yet a full life so... ( <i>long pause</i> )
6 Teacher:	So what Dianne? ( <b>Ana; Increa pers</b> )
7 Dianne:	Ma'am so it's not yet complete and after it developed, it can now be considered
8	as a new life
9 Renan:	As long as it doesn't look like Alien Ma'am!
10 Teacher:	It doesn't look like alien? Haha...how did you think of that? What we mean is
11	that it's artificial? ( <b>Recap, recast</b> )
12 Renan:	Ma'am its already artificial coz the normal way to form a baby is for a male
	and female to do, Ma'am you know...
13 Teacher:	Ok, maybe... Anyone who disagrees that it's not normal? ( <b>Ana; Increa pers</b> )
14 Dennis:	Ma'am I agree with Renan! Like it's better to have the normal way to have a
	baby?

Based Transcript 2, two students presented their conclusive arguments that could probably have ended their discussion in a traditional classroom, if the teachers provided immediate evaluative responses. However, in Teacher Loida's case, she did not provide any evaluative response instead she extended the discussion by waiting and encouraging the previous student (Dianne) to elaborate on her statement. Moreover, even after two responses from Dianne and Renan (Line 7 to 9), Line 10 to 11 shows that she recapitulated and recasted the previous student's statement ("*It doesn't look like alien? Haha...how did you think of that? What we mean is that, it's artificial?*") which prompted further explanations. Furthermore, even though students had already presented their claims, evidences, and justifications, she still tried to elicit counterarguments when she asked, "*Anyone who disagrees that it's not normal?*" (Line 13) and this elicited Dennis'



supportive statement to Renan in Line 14.

It can be inferred in Transcript 2 that she was keen to accommodate her students' responses and find their place in the discussion. Moreover, as she did not give immediate evaluative prompts, students recognized their roles in the discussion and continued to respond which served as signals and encouraged others to participate. Furthermore, Teacher Loida used simple words and defined unfamiliar terms which served as linguistic supports to increase the dynamic interplay of their interactive discussion. In addition, using prior scientific knowledge, she was able to increase the argumentative agency of the students by increasing their responsibility to formulate back-up statements. Lastly, to foster their argumentative skills, Teacher Loida was quick in providing 'what if' statements that encouraged the students to think and decide about specific situations from varying viewpoints.

### ***Theme 2: Enactment of the culture of negotiation***

The advocacy towards the use of argumentation in classroom argumentation is that, its use should lean towards cooperative enterprise of dialogic exchange where competing claims will not lead to chaos in the discussions (Mitchell, 1998). While it does not completely mean to eliminate the counterargumentation in the process, it has been advocated that through negotiation, the argumentative discussions would result to mutual and satisfactory outcomes when centered on discursive knowledge construction. Negotiation in the process, involves expressions of both competing and non-competing claims with reasoned arguments for and against a proposition which would eventually lead to a collaborative consensus in a welcoming behavior. While some individuals in an argumentative scenario possess certain and right answers, negotiation in classroom argumentation concerns about the combination of healthy competition of ideas and cooperative dialogic exchange while facilitating participants to decide rationally.

In Teacher Carlo's class, the culture of negotiation in their argumentative discussions was consciously enacted. Because he was aware that most of his students were opinionated, he ensured that they expressed their reasoned arguments not in a competitive state but more of expressing their knowledge which contingently and dialogically scaffolded each other. In their negotiated argumentation, dialogic exchange did not preclude attempts to establish common grounds and mutually satisfactory evidences to claims which progressed into a productive dialogue and avoided the notion of winning sides. As he considered the developmental learning stages of his students, he deliberately initiated a negotiated argumentation that led to a cooperative and mutual search for consensus in a more modest and friendly learning environment. During the interview, he mentioned that part of his decision to implement argumentation in his Biology Elective class is the setting of the rules and making the students embrace cooperative learning environment. While they were allowed to freely express and defend their ideas, they should do these with non-disruptive behaviors and not in a win-lose scenario. Thus through his dialogic prompts, he successfully scaffolded his students to maintain a pleasant learning environment and cooperative discussion which avoided the win-loss dichotomy of a competitive argumentation. Especially in the contingency phase of their argumentative discussion, he prioritized giving neutral points to elicit responses and was keen enough to converge disparate ideas when the dialogic exchange was gradually turning into a competitive situation.

The culture of negotiated argumentation can be illustrated in the discussions which are shown in Transcripts 3 and 4. In Transcript 3, during their discussion on ethical frameworks, he asked about which one to prioritize in doing research; whether the scientific value of it or the ethical value of it. To initiate the culture of negotiation, his dialogic prompt contained the background information on both sides. Thus, in Line 6 to 7, Carl's initial response was also encompassing of both ethical and scientific values. But this served as a signal for him that the

discussion will immediately end. Therefore, he elicited further responses by asking for examples in order to illustrate how Carl's claims can be manifested in scientific research. Carl was not prompted for elaboration but instead, Grace responded in support and in behalf of Carl with her example on "pain tolerance." This was then acknowledged by Teacher Carlo and Carl gained back his confidence and gave the 'Nazi experiment' as his example. Through this example, Jean was prompted to express her argumentative agency to evaluate the example. However, it can be noted in her evaluative response that she was not expressing her competing claims but instead, she was trying to recall what happened in the Nazi experiment to illustrate the ethical and scientific value of the research process. As she elaborated her responses, Teacher Carlo, scaffolded Carl for his reasoned arguments but because of the clarity in Jean's explanation, Carl conceded in Line 22. The culture of negotiation is evident in that Teacher Carlo was responsive enough to ask and listen to both sides when claims were expressed, counterargued, and justified. As in the case of Jean and Carl in the Line 13 to 19, Carl's claims were refuted and properly justified by Jean. But after hearing Jean's side, Teacher Carlo still gave the chance for Carl to justify his claims in Line 20 to 21 when he asked, "*Carl can you elaborate on this.. Jean is counterarguing your claim.*"

In the succeeding interactions in Transcript 3, Teacher Carlo gave 'clinical trial stage 1' as an example and continuously asked the students to assess it for its ethical and scientific value. Series of responses which started from Jacob indicated two-sided and negotiated argument with his response on the increase of the scientific value when participants were compromised. This implied that Jacob was refuting Teacher Carlo's example but he was able to express his claim in a friendly way. Teacher Carlo's negotiated dialogic prompts elicited the supportive argumentative agency of Gem when she further elaborated on the increase or decrease of ethical and scientific value in clinical trial stage experiments.

Similar negotiated argumentation occurred in Transcript 4 when they tried to establish their final decisions whether one deserves informed consent prior to quarantine procedures. In Louise response in Line 2 to 4, she expressed her reasoned arguments that *“it is a must”* to obey medical quarantine officials but at the same time, one deserves to be treated properly. This response invited series of supportive opinions from Francia, Jacob, Carl, and Gil with all their opinions converging into consensus with similar claims supportive of Louise. Along the way in Line 15 to 16, Teacher Carlo supplemented their consensus saying that in quarantine sites, all quarantined individuals are treated properly. Thus, final and overall consensus was achieved with the summary of Gil in Line 18 to when he said, *“that clears the issue now”* as a follow-up response to Teacher Carlo.

Based on the transcripts, the negotiated dialogic scaffolding of Teacher Carlo was successful in instigating a cooperative classroom argumentation. Students’ responses contained integrative bargaining of ideas which finally converged into agreement where everyone was made amenable of it. In fact, consensus was usually in the form of summary statements which tried to consider all salient points from the previous responses such as those of Gem’s in Line 30 to 32 in Transcript 3 and in Gil’s summary in Lines 17 to 20 in Transcript 4. Moreover, as students were given enough opportunities to share their ideas despite refutations, they felt at ease in expressing their argumentative agency and were more flexible in the negotiation of their ideas when clear evidences were provided. Thus, it can be inferred that in the process of negotiation, they were able to develop their subjective aspect of nature of science by acknowledging the reality that all ideas can be subjected to refutations. Most importantly, their classroom became a venue for a learning environment where most of the talking was done by the students with emphasis on the important points in the discussion as they negotiated the construction and reconstruction of their knowledge.

*Offering neutral points of view as prerequisites for integrative negotiation.* According to Crusius and Channell (1994), the process of negotiation lets go of the whole idea that one side should be proven right and the other side be proven wrong. In Teacher Carlo's class, it was observed that most of their lessons encouraged debate structures of complex ideas that demanded one of the two-sided alternatives to be strengthened in order to refute one side. However, since his class was not designed for this purpose, he usually used the contingency phases to present equal strengths of both sides of the issue in order to draw out students' responses. Moreover, as students were used to such a learning environment since the start of their classes, their points of view led to an integrative negotiation which resulted to the formation of a wider range of satisfactory possibilities.

For instance, in Transcript 3, Teacher Carlo offered his contingent dialogic prompt about the equal importance of ethical value and scientific value with equal strengths and devoid of faulty and hidden assumptions. Through this, he minimized students' overinterpretation of his initial stance. In the transcript, Carl's initial response indicated a neutral stand ("*...we have to work on the maximum potential of both*"). Acknowledging Carl's neutral response, he increased the students' perspective to participate in the discussion when he prompted them to give an example that supported Carl's argument. When Grace cited 'pain tolerance' as a typical example (Line 10 to 11), he recapped this and the discussion was immediately replaced with the topic on the Nazi experiment introduced by Carl when he gained back his argumentative agency to respond. The introduction of the Nazi experiment resulted to a series of students expressing their argumentative agencies which started with Jean who challenged the idea by giving elaborated response about the place of the Nazi experiment as an example to illustrate ethical and scientific value at the same time (Line 14 to 16). With that challenging statement, Carl expressed his argumentative agency to reason out which was again evaluated by Jean (Line 18 to 19). With these series of interactions from Jean and

Carl, Teacher Carlo intervened by encouraging and increasing Carl's argumentative agency by asking him to elaborate on his stand but Carl accepted the weaknesses of his ideas.

Still not reaching consensus, Teacher Carlo introduced another scenario using 'clinical trial activities' as an example to accommodate the equal importance of valuing both ethical and scientific value of doing research (Line 23 to 25). Aiming for a consensus, students were keen to offer all possible examples to which Teacher Carlo was responsive enough to ask for elaborations. This issue was settled when Gem summarized the discussion using the importance of following the universal standards in doing research especially for those which require human samples and clinical trials (Line 34 to 37). This transcript shows how Teacher Carlo's constructivism facilitated a neutral discussion which yielded equitable participation and provided a greater opportunity for student-led discussions. Taking it as a whole, this contingent strategy for classroom argumentation showed dialogic scaffolding not only as a pedagogy but also a way of recognizing every students' voices as they expressed their prior knowledge and navigated their expressions of argumentative agency using language in a responsive and respectful environment.

Transcript 3. *Fragment of the Classroom Transcript on Lesson 'Ethical Frameworks' (Lesson 1, 05-02-2018)*

Speaker	Dialogic interactions
1 Teacher:	Ok, say we have a scale, a balance for ethical value or scientific value. Can we
2	work them together? Or it could never be... like "sir, as long as you push with
3	the scientific value, there will come a time that there will be a compromise of the
4	ethical value or the other way around? Is it always the case? Or is it a false
5	dichotomy? Any other opinions? <b>(Ana; Increa pers)</b>
6 Carl:	Sir, there are models anyway that we can follow...like we have to work on the
7	maximum potential of both... <b>(Reas)</b>
8 Teacher:	Ok...now, can you give me an example which shows that the increase in
9	scientific value equals the increase of the ethical value? <b>(Conc; Cued eli)</b>
10 Grace:	Sir, pain tolerance. Coz you are conducting a research, but you are giving them
11	pain... <b>(Supp)</b>
12 Teacher:	Pain tolerance...ok, it can be...because you are giving pain... <b>(Conc; Recap)</b>
13 Carl:	Nazi experiment!? <b>(Supp)</b>
14 Jean:	The Nazi experiment? Is it not that the ethical standard here sacrificed? They
15	forced the participants and there were no consent given for the procedures, right?
16	And it resulted to a lot of trauma... <b>(Chall)</b>
17 Carl:	But the result of the experiment is to develop ways to recover from war...

### Transcript 3 (continued)

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18 Jean: So, it's only the scientific value that is considered here. The ethical part of the  
19 research was set aside. **(Eval)**

20 **Teacher:** Nazi experiment! Carl, can you elaborate on this? Jean is counter arguing your  
21 claim. **(Conc; Increa pers)**

22 Carl: Ah, Sir, maybe I just did not see that fully...

23 **Teacher:** Ok! Can we consider clinical trial stage 1 as an example of this...In this case,  
24 just to know if the research has a certain value...as long as you treat them as  
25 people. Yes Jacob...**(Ana; Increa pers)**

26 Jacob: Sir, if you compromise the participants, I think the ethical value will decrease...

27 Gem: Sir what is the case of the Stanford prison experiment...they abide with the  
28 standard ethical procedures but still, there was an issue on it? **(Cla)**

29 **Teacher:** In that case, did the scientific value of the research decrease? **(Conc; Pri knowl;  
Ana; Pres arg prompts)**

30 Gem: I think it did not decrease...but the ethical procedure was compromised. Like in  
31 the process of conducting the experiment, some of the participants already  
32 expressed withdrawal from the research but they were not allowed. **(Reas)**

33 **Teacher:** I think, it is also good to discuss what happened... **(Conc; Cued eli)**

34 Gem: Sir, it seems the scientific value did not decrease coz just the same, they got what  
35 they are supposed to get from the data. But again, if we are taking universal  
36 standards to be for the ethical side, I think, these works for both for scientific  
37 value and ethical value. **(Reas)**

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*Converging disparate ideas leading to collective consensus.* According to Hmelo-Silver and Barrows (2008), argumentative discussions can support knowledge-building as participants 'negotiate a fit between their own ideas and those of others and use the differences they find to catalyze knowledge advancement' (p. 49). As Teacher Carlo mentioned that his students were used to classroom argumentation as his primary instructional strategy, his contingent dialogic prompts converged their varying viewpoints and in the process of negotiation, they considered the strengths of others' ideas against their own for a shared knowledge building through dialogic interaction.

This can be illustrated in Transcript 4 during their discussion on their lesson on the 'ethics on quarantine.' From the transcript, with his first argumentative statement regarding 'invoking one's right to be quarantined,' Louise' immediate response was a disagreement backing up her claim with an emphasis on the responsibility to obey medical authorities and that people can demand for their rights by asking for proper treatment during quarantine sessions (Line 2 to 5). This was supported by Francia with her claim for proper notification of the reasons for

being quarantined. To extend the discussion, Teacher Carlo introduced the issue of informed consent which elicited more arguments from the students (Line 6). Sparse analytical dialogic prompts elicited students' responses with varying viewpoints but when disparate ideas arose, he tried to establish common convergence points towards consensus building. Through that dialogic prompt, Gil almost established a consensus (Line 17 to 20) but Matthew introduced the topic on freedom (Line 21), then recasted by Teacher Carlo which gave him the responsibility to continue the discussion making him (Matthew) express his overall opinions with emphasis on the parallel importance of responsibility and freedom (Line 23 to 27).

Based on Transcript 4, it should be clear that Teacher Carlo's recapping of previous student's ideas was not used to silence the others and see them as less important. In most of the classes, similar events led to openness to revise arguments and as they moved towards a consensus, a set of social norms in their discursive interactions slowly emerged as students expressed their argumentative agency without demonstration of power and superiority for their ideas. In the transcript, Teacher Carlo's dialogues in Line 15 to 16 prompted Gil to clear the issues at hand as he initiated sensemaking. In his consensus dialogue, he used Teacher Carlo's statement as evidence in an attempt to strengthen his summarized claims but not discrediting the value of the previous reasons from his peers. Much as majority of interactions came from the elaborated responses of the students, when Teacher Carlo felt the need to scaffold the interactions, he was responsive enough to create a safe discussion for the students to express their healthy sense of competence without suppressing and impinging one another's interaction space.



Transcript 4. *Fragment of the Classroom Transcript on Lesson ‘Quarantine’ (Lesson 3, 07-02-2018)*

Speaker	Dialogic Interactions
1 <b>Teacher:</b>	But do you really invoke your right to say “No” for being quarantined. ( <b>Ana; Increa pers</b> )
2 Louise:	Sir, you don’t have the right. It is a MUST to obey medical authorities in these
3	times. For as long as you are to be treated properly, I think, it is a
4	responsibility...or else, you will become the source of the disease for the public. ( <b>Reas</b> )
5 Francia:	And one more thing Sir, is that they should be given information on their cases. ( <b>Sup</b> )
6 <b>Teacher:</b>	Do we still need to give them informed consent? ( <b>Ana; Increa pers</b> )
7 Francia:	Sir, no more...what I mean is that while they are being monitored, they are
8	given information on the status of their health...like if they are risky or not... ( <b>Eval</b> )
9 Jacob:	Sir, I don’t think you need to be given informed consent...simply being aware
10	that you were exposed to a place which is a source of an epidemic is your
11	responsibility to subject yourself for quarantine. And the final stage of
12	quarantine anyway is either for you to be treated is you are infected and to be
13	released if you’re not infected. ( <b>Sup</b> )
14 Carl:	I agree Sir, for as long as you are treated properly. ( <b>Sup</b> )
15 <b>Teacher:</b>	Yeah, in quarantine areas, you are given food in a conducive place that will not
16	harm your well-being. ( <b>Conc; Recap</b> )
17 Gil:	So Sir...that clears the issue now. Being quarantined is a responsibility and you
18	don’t need an informed consent for as long as you are given enough information
19	as to why you were subjected to quarantine...and you are given enough
20	information on your health status. ( <b>Reas</b> )
21 Matthew:	Sir, how about your freedom? In this case, how can I practice my freedom? ( <b>Chall</b> )
22 <b>Teacher:</b>	What about freedom? ( <b>Ana; Increa pers</b> )
23 Matthew:	Sir, I have the right to say No... coz it’s my freedom. But being free is always
24	coupled with the responsibility. It’s like, you have the rights, you have the
25	privileges and you also have the responsibility. So in this case, you have the
26	responsibility to ensure that you will not be the source of the disease for the
27	community. ( <b>Reas</b> )

**Content-based implementing teachers.** Similarly, the content-based implementing teachers had their own dialogic scaffolding practices in the contingency phases of their discussion. Teacher Don used the conceptual-reflective questioning strategy and this was implemented by: 1) questioning using factual-canonical concepts, and 2) extending discussion through reflective inquiry. On the other hand, Teacher Mara used the flexible affirmations of students’ ideas for collective consensus and she implemented this by: 1) providing reinforcement for a mutually contingent dialogic exercise, and 2) revoicing to increase students’ backing and enhance their discursive identity.

### ***Theme 3: Conceptual-reflective questioning strategies***

Questioning persists to remain as a significant part of the activities in classroom learning environment. Usually it starts with conceptual questions where students are prompted to provide exact or definite answers. However, this has been used in traditional classroom where teachers ask predetermined questions which deserves a specific right answer. In the process, students start to develop the idea that learning is memorizing facts which would prepare them for recitation in class. In dialogic and argumentative classrooms, teachers are advised to minimize this question-answer pattern of discussion but rather must focus their attention in eliciting students' explanations for their answers. This was evident in Teacher Don's Class when he used a combination of conceptual and reflective dialogic prompts as his dialogic scaffolding statements for classroom argumentation. Since he framed his classroom argumentation to be content-based, conceptual dialogic prompts were used to introduce the topics of their lesson. Reflective dialogues were used to elicit students' opinions when their discussions slowly progressed into the application part where they tried to identify the direct application of their scientific concepts to daily lives. Analytical questions were also observed when he tried to build connections of the students' responses with previous knowledge to draw their attention to the interrelatedness of the scientific concepts they were discussing. As such, he traded direct instruction and transmission of knowledge over collaborative knowledge construction where students expressed their argumentative agency with either constructive or critic dialogic roles during their dynamic exchange of ideas. Moreover, their argumentative learning environment turned into question-driven inquiry wherein questions were used to stimulate thinking, look for evidence to support claims, evaluate and communicate arguments, and eventually, achieve the objectives of the lesson. Dialogic scaffolding in this case therefore, is seen not "purely" as a support to the students but an approach to classroom argumentation aiming to recognize their innate

capacities to share the prior knowledge and bring in their cultural backgrounds as they are prompted to express their argumentative agency.

As this has been the practice of Teacher Don in his Biology class, students became accustomed to it and gained confidence to express unsolicited responses when they became more motivated to share their knowledge. Contingency phase became the period when the students tried to locate their dialogic positions in the discussions when prompted with ideas which either relate to their current knowledge or to their direct experiences. As Teacher Don was aware of the students' zone of proximal learning capacities, he tried to alternate conceptual and reflective questioning as a form of dynamic assessment. Thus, conceptual and reflective questioning served as the method of establishing dialogic inquiry where students became active agents in the learning process. In the reflective questions, thought-provoking responses gave rise to succeeding answers or questions which widened the sphere of their discussions. In the contingency phase where dialogic scaffolding prompts were prominent in the stabilization of the argumentative discussions, Teacher Don's questions served as scaffolds to request for further thinking, reasoning, justifying, and evaluating their claims.

The conceptual and dialogic questioning of Teacher Don in the contingency phase was crucial in facilitating the dialogic inquiry. However, based on the sample transcripts, his dialogic prompts did not sacrifice the students' initiatives for unsolicited responses; rather, he even provided "wait time" for them to arrange their thoughts. As he allowed them for further elaborations, their ideas became scaffolds to either his prompts or to the dialogues of their peers. In fact most of the time, his dialogic prompts invited students to strengthen their claims with evidences when he recapped or recapitulated their answers. It was also his way to recognize the value of their participation which motivated them to engage more. By including their responses in the subsequent questions, their dialogic exchange became mutual contingents for each other.

In Transcripts 5 and 6, the advantages of alternating conceptual and reflective questioning can be observed in the dialogic interactions. In Transcript 5, it was evident that the alternating conceptual and reflective dialogic scaffolding prompts of Teacher Don encouraged more participation among the students and that the students expressed their argumentative agency to either support, provide further reasons, or critic him or their peers. In this discussion, he started their dialogic interaction with a very simple conceptual question on why mushrooms are sticky. The initial response from Bryan was a description to which this was included in his subsequent question. The discussion was suddenly shifted when Dianne mentioned about the frequent occurrence of mushrooms during rainy seasons. This was somehow related to the habitat of mushrooms which was the direct implication of what Bryan told in Line 2. These ideas were again included in the succeeding dialogic prompts of Teacher Don making the students feel motivated as their answers were continuously being recognized. He even asked them if they knew of some studies that would support this claim. At this stage, his dialogic prompt was trying to elicit supportive evidences, thus allowing them to read their notes. However, after reading the notes, other ideas like the excitation of mushroom's hypha by the jolts of electrical energy from lightning and thunder were brought out. As this was recapitulated by Teacher Don, the discussion then shifted to a conceptual question which prompted the students to relate the appearance of mushrooms to the role of electrical energy. As their discussion continued, the alternating conceptual and reflective questions of Teacher Don served as the dialogic support for the students to resolve their doubts about the appearance of mushroom during stormy weather because they were able to recognize the role of electrical energy in the process. It can also be observed that they were able to recall on the reproductive parts of the flower which they related to the spores in the hypha—the excited parts of the mushroom body during lightning. This facilitated the formation of their scientific knowledge about the mode of

reproduction in mushrooms, the role of spores, and the role of the jolts of electrical energy. Based on these lines of thought, it can be observed that with a combination of conceptual and reflective dialogic prompts, a simple question as in Line 1 of this transcript can be developed into the proper construction and reconstruction of scientific ideas. As Teacher Don was willing to allow his students to participate, their dialogic inquiry was successful when their prior knowledge and experiences were shared through language. Moreover, they were able to develop their communication skills in the process of negotiated learning when significant parts of their ideas were recognized in the succeeding conceptual and reflective questions.

Similar scenario was observed in the dialogic exchange in Transcript 6. The simple question, "*In what way are they similar?*" encouraged series of responses which converged into the enumeration of the characteristics of protists. When the habitat of protists was brought into the discussion, Teacher Carlo was quick enough to formulate another analytical question which developed into a reflective inquiry about the feeding patterns involving fish and algae. It was clear that through dialogic scaffolding, current topics can be linked to previous scientific knowledge through the responses of the students. As long as their responses were properly recognized, they become motivated to think and organize their prior knowledge in order to provide evidences for their claims.

***Questioning using factual-canonical concepts.*** In the Transcript 5 which shows a sample contingency phase of Teacher Don's class on their lesson on 'Kingdom Protista,' it can be observed that his dialogic prompts were mostly confined to conceptual dialogues with dialogic roles of cued eliciting and recasting. In this transcript, after giving cues to elicit students' interactions, he recasted and then appropriated Bryan's response (Line 3 to 4) in order to build a more scientific statement by telling the students that fungus-like protists are usually found in moist environments. Without any dialogic prompt, Dianne introduced the role of

'lightning' in the propagation of mushrooms (Line 5) which was supported by Billy (Line 6 to 7). Thus, Teacher Don elicited more responses by handing back the responsibility to the students to expound on the topic.

There were also instances wherein despite giving students some cues and providing 'wait time,' they were still not able to respond to his questions. Nonetheless, this did not tempt him to give lectures but instead, he kept on giving cues like allowing them to read their research assignments to increase their participation when he sensed that they cannot express the terms using their own words or simplify the broad ideas. In Transcript 5, when there was no response after waiting for three seconds for his question about the findings of current research on the role of lightning in the increasing number of mushrooms, he provided them a dialogic cue to read from their source (Line 10 to 11).

Gaining confidence to respond due to the cue, Dianne then read the details from the printed copy of her research which mentioned the parts of the fungus such as the hypha. Teacher Don recasted that portion, emphasized the role of the hypha, and tried to link it to students' prior knowledge about spores (Line 18). When Jenn was able to relate the function of hypha with pollen grains (Line 19), Teacher Don appropriated the concept and linked it to their prior knowledge on the role of pollen grains in the process of pollination which might be similar to the role of fruiting bodies in fungi. He finally recapped Randy's answer ("*plant them*") and tried to link the concept of electrical energy and the excitation of the hypha during lightning (Line 27 to 30). Randy was then prompted to say that, "*the lightning will bombard the hyphae,*" which was supported by Jena in Line 32 to 33 whose statement finally led the class to a common understanding on the 'relationship of the increasing appearances of mushrooms during lightning' which was introduced by Dianne in the earlier part of their discussion.

Transcript 5 represents similar classroom scenarios in Teacher Don's class which, despite the dominance of his conceptual dialogues; his reflective dialogues

were effective in encouraging the students to extend their thinking beyond the conceptual knowledge to identifying the applications of their scientific understanding to the local scenarios that they usually experience in their daily lives. Moreover, through his reflective dialogues, he was able to make the students identify the interrelatedness of their scientific understanding (e. g. Kingdom Protista to pollination) and encourage the expressions of their argumentative agency which sustained and extended their discussions.

It is also important to note that he was able to minimize direct evaluative statements, thus allowing the students to generate their own conceptual understanding. Moreover, it can be observed in their discussions that he used their previous knowledge and led them to relate those prior concepts to the current lesson such as relating the reproductive parts of the plant (pollen grains) to the mode of reproduction of fungi. This dialogic scaffolding practice aligns with the Vygotsky's sociocultural theory when Teacher Don sought out previous knowledge of students about plant reproduction through his conceptual questions and made connections to the current classroom interactions through reflective prompts. As such, he was able to initiate the collective negotiation of how knowledge can be formed by cueing his students which nurtured their mutual and cooperative build-up of scientific understanding.

Transcript 5. *Fragment of the Classroom Transcript on Lesson 'Kingdom Protista' (Lesson 4, 17-01-2018)*

Speaker	Dialogic interactions
1	<b>Teacher:</b> Why are they sticky? ( <b>Conc; Cued eli</b> )
2	Bryan: They are wet.
3	<b>Teacher:</b> Ok, they are slightly wet... or what we call, moist...so they live in moist
4	environment ( <b>Conc; Recast, Appro</b> )
5	Dianne: Sir I read that during lightning and thunder, more mushrooms are coming out!
6	Billy: Yes Sir, that's why there are so many people who gather mushrooms during
7	lightning and they sell the next day!
8	<b>Teacher:</b> For those who read that, what did you find out about that? ( <b>Conc; Increa per; Cued eli</b> )
9	Dianne: Sir I read, they don't know... but they are doing research...
10	<b>Teacher:</b> And what does their research say? ( <i>Waits for 3 seconds</i> )... You can read what
11	you have in there... ( <b>Cued eli</b> )

### Transcript 5 (continued)

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- 12 Dianne: Sir, I will read! The jolts of electrical energy seem to excite the hyphae and make  
13 them work harder...Sir I don't know the hyphae...
- 14 **Teacher:** Ok, who was able to read about the hyphae? (**Conc; Recast, Cued eli**)
- 15 Mila: Sir, they form the fruiting bodies...Sir what is that?
- 16 **Teacher:** Who knows about the fruiting bodies? (**Conc; Link prior exp**)
- 17 Lina: Sir, spores...
- 18 **Teacher:** And what do you know about spores? Anyone? ... relate it to fruiting bodies...  
(**Conc; Link prior exp**)
- 19 Jenn: Sir, is it like pollen grains?
- 20 **Teacher:** Ok, yeah, they are like pollen grains! And what do pollen grains do? (**Conc;**  
**Appro**)
- 21 Richard: They make flowers... ah ah ah...fruits, seeds
- 22 **Teacher:** Ok, what are those parts of the plant, fruits, seeds, flowers? If you have seeds,  
23 what can you do with the seeds? (**Conc; Link prior exp**)
- 24 Ryan: Sir plant them...
- 25 **Teacher:** So if you plant them, what did you do? (**Conc; Recast**)
- 26 Randy: Sir, make more plants!
- 27 **Teacher:** Ok, so you make more plants...or you reproduce them...now, in fungi, we  
28 cannot find seeds but instead we find spores or the fruiting bodies...Ok let us  
29 relate what Dianne said that the electrical energy excite the hyphae...how can  
30 you relate that to the growing number of mushrooms during lightning? (**Conc;**  
**Recap**)
- 31 Randy: Sir, the lightning will bombard the hyphae
- 32 Jena: So they will explode! And they will be scattered! So there will be more  
33 mushrooms!
- 34 **Teacher:** You are right! That's really it is, maybe! But of course, as you have said earlier,  
35 they don't know yet, so they are studying it more. For now, that's what we know  
36 and we will wait for further studies.
- 37 Jim: Sir, let's wait for the scientists!
- 

*Extending discussion through reflective inquiry.* According to Lee and Barnett (1994), reflective questioning can establish confidentiality and non-judgmental stance in the interaction. In Teacher Don's class, his students interpreted his reflective questions as his way to encourage them to reveal their thoughts without fear of censure and thus, they communicated their ideas with reference to themselves which most of the time were welcomed as springboards for others to present their alternative ideas. For instance in Transcript 6, it can be observed that Teacher Don allowed the students to express their ideas after his initial dialogic prompt in Line 1 so that in Line 7, he recapped Bing's statement and followed it up with a reflective dialogic prompt. Recapping and reflective questioning served as linking statements to the succeeding series of interactions which resulted to students' expressions of argumentative agency such as by



Michelle (Line 9) with her counterargument to evaluate Renz' idea about the role of algae to feed the fishes.

Using linking statements, Teacher Don acknowledged the contributions of the previous students in the discussion as his way of giving value to their position. Additionally, it served as a form of mirroring back to previous ideas, setting aside his own interpretation but leading to engage the students to resolve the issues in the lesson on their own. In Transcript 5, the conceptual problem started with the importance of algae which was resolved with Bryan's statement that they are the sources of food for fish (Line 12). This progressed into another issue about feeding patterns of fish when Denver introduced the niche of small fish as food source to bigger ones (Line 17 to 18). This response prompted Linda to clarify and revise Denver's statement (Line 20) making Teacher Don formulate another reflective statement (Line 21) on the importance of algae in stabilizing the feeding patterns (food chain) and maintaining fish population in the ocean.

It can be observed from this interaction that the first dialogic prompt of Teacher Don was simply eliciting prior conceptual knowledge of the students. However, as he continued to recast and use their responses to formulate conceptual, analytical, and reflective questions such as in Lines 7, 14 and 21, he was able to establish a dialogic interaction in the classroom which elicited students' expressions of their argumentative agency. This supports Corson's (1988) claim about the potential of reflective questions to spark dialogic inquiry by prompting students "towards more sustained levels of formal-operational thinking by providing them with regular opportunities for dialogue with others" (p. 66). This therefore aligns with the scaffolding concept because their gradual engagement in dialogic interaction built their analytical competence. The knowledge they formed from their responses and their developed skills to communicate and negotiate ideas from the reflective dialogic prompts can be inferred to serve as foundations for their future schooling.

Transcript 6. *Fragment on the classroom transcript on lesson 'Kingdom Protista' (Lesson 4,17-01-2018)*

Speaker	Dialogic interactions
1 Teacher:	In what way are they similar? Group 2! <b>(Conc; Pri knowl)</b>
2 Rina:	Sir the plant-like protists have chlorophyll.
3 Jim:	They can make their own food. <b>(Supp)</b>
4 Bryan:	They have cell walls! <b>(Supp)</b>
5 Lian:	They have root-like...like plants! <b>(Supp)</b>
6 Bing:	Sir, they live in the oceans. <b>(Supp)</b>
7 Teacher:	Ok, we can find them in oceans...why? <b>(Ana; Appr, Increa pers)</b>
8 Renz:	They feed the fishes... <b>(Reas)</b>
9 Michelle:	What? They feed the fishes? Haha! Fishes eat them! <b>(Chall)</b>
10 Renz:	Ok...it's just the same.
11 Michelle:	How can they feed the fishes? They have no hands! <b>(Chall)</b>
12 Bryan:	Fishes feed on them! <b>(Cla)</b>
13 Renz:	Ok, I'm wrong!
14 Teacher:	Ok, so fishes feed on them. So without them, will there be food for fishes? <b>(Conc; Recast; Cued eli)</b>
15 Claire:	No Sir! So fishes will die! <b>(Reas)</b>
16 Rina:	So if there will be no algae, fishes will eat other fishes! <b>(Reas)</b>
17 Denver:	But not all fishes can feed on fishes. There are fishes who eat only algae! So they will die. <b>(Chal)</b>
18 Dave:	So if they die, there will be no fish for the big fish! <b>(Reas)</b>
20 Linda:	What? No fish for the big fish? No food for the big fish! <b>(Eval)</b>
21 Teacher:	So are they important? <b>(Ana; Increa pers)</b>
22 Linda:	Yes Sir, coz if the small fish will die, the big fish will not have food. And they will eat their fellow big fishes... and there will be less fish in the ocean. Only big fish who survive! <b>(Reas)</b>
25 Teacher:	Ok, what do we call those food relationships? Or eating relationships? Yes Diana! <b>(Conc; Pri knowl)</b>
26 Diana:	Food chain!

Based on Transcript 6, it can be understood that Teacher Don's reflective dialogic prompts led to the success of the argumentative interaction and expressions of students' argumentative agency. Their discussion as illustrated in the transcript clearly showed the building up of ideas as Teacher Don focused on valuing each student's contribution, summarizing them into another reflective dialogic prompts, and using these as opportunities to elicit more responses for an extended and collaborative dialogic classroom interactions. It can therefore be concluded that these factual and canonical reflective dialogues served as supporting and guiding statements for an atmosphere where students engaged and valued the excitement of being part of the spirit of collective learning.

#### ***Theme 4: Flexible affirmations of students' ideas for collective consensus***

Affirmations and reinforcements have always been implicated in the learning environment. Through affirmation strategies, learners are surely provided with secure learning environment with predictable rewards in advance. In dialogic scaffolding, this can be observed during the students' expressions of their argumentative agency. As their dialogues were recasted by their teacher, they became motivated to increase their participation knowing that their ideas have significant roles in the continuity of discussion and in channeling the development of scientific knowledge. This was observed in the content-based class of Teacher Mara. Through her dialogic prompts of continuously recasting the students' dialogues, violent reactions were avoided with her use of neutral statements. Moreover, as she did not give evaluative prompts, students continued expressing their varying viewpoints; thus faulty reasons were dialogically scaffolded and clarified by others. Clarifications were always welcomed in the discussions with immediate answers from knowledgeable students who provided enough and clear reasons. This were usually in the form of summative statements which were encompassing of previous chains of reasons that were relevant enough to form the expected concepts.

In this contingent dialogic scaffolding practice of Teacher Mara, her prompts were favorable to the students' development of knowledge. In their dialogic exchange, the frequent occurrence of her recasting dialogic roles lowered the possibility of incidence of competitive behaviors and increased collaborative dialogues in consensus building. This is aligned to the definition of Mercer and Littleton (2007) whose ideas about collaborative knowledge building was characterized by both students and teachers alternately involved in the coordinated attempts of problem-solving and conflict resolution in the knowledge construction. Accordingly, Mercer (2008) claimed that together with the content, the functional structure of educational dialogues contributes to the focused, sustained, and

reasoned development of conceptual understanding.

According to Craig et al. (2011), a great deal is put into how teachers can influence the students' motivation through dialogues. In this study, Teacher Mara's dialogic scaffolding practices increased the students' active cognition and provided opportunities to foster verbal engagement with deeper quality of reasoning. By not anticipating responses, Teacher Mara's affirmative dialogic scaffolding prompts were purely focused and attentive on what the students were currently saying, rather than on the predetermined correct answers. Thus, extended elicitation of correct answers involved a series of dialogic exchange which encouraged the students to articulate either their constructive or critical argumentative agency. As affirmative statements were constantly provided, low-cognitive level responses were leveraged to more clarified and meaningful statements with further elaborated responses in a form of rebuttal or refutation. Focusing not only on the content learning, the dialogic inquiry enhanced the students' social skills through their communication and negotiation skills.

As exemplified in Transcripts 7 and 8, Teacher Mara kept on acknowledging the statements of the students and revoicing them as a form of mutual contingent dialogue to elicit more responses. Through reflective dialogic prompts, she kept on drawing out further explanations and minimized corrective feedbacks which might contradict her affirmative dialogues. For instance in Line 10 in Transcript 7, when her question was given an elaborated answer by Francis in Line 11 and 12, she used Diana's, Leslie's, Linda's, and Kevin's reasons from their previous responses to bring out the formal topic of their discussion which was the understanding of the advantages of studying the pattern of inheritance. It can be noticed in the transcript that the common grounds in the students' ideas were supportive of each other and as early as the first statement, the correct answer was already explained. However, she tried to draw out more ideas and increase the depth of knowledge formation by asking reflective questions resulting to answers

from varied points of view.

In the dialogic exchange, she tried to bring out students' opinions on the significance of the mode of inheritance in humans. In Line 3 of Transcript 7, Diana was right when she said that they need to study the patterns of inheritance as prerequisite knowledge to understand the inheritance of diseases. As she recognized and recasted her answer, a related reason was provided by Leslie when she said about health management. Moreover, these answers were supplemented by the succeeding responses of Linda with supportive statement relating the studying mode of inheritance in humans to maintaining healthy lifestyle and further explained by Kevin using an example from his experience.

Providing affirmative dialogic prompts as scaffolds in this study was regarded as allocating everyone's role in the discussion and giving them space to express their varying opinions which served as grounds for mutual exchange and building of scientific concepts. The varying viewpoints however, were recognized by everyone as their foundational knowledge which was influenced by their culture, schemas, and prior experiences. Thus, dialogic inquiry in Teacher Mara's classroom can be synonymous to collective argumentation where ideas were recognized, understood, and clarified in order to reach agreement with broader validated reasons from different perspectives. Through this dialogic scaffolding practice, their inquiry process opened new perspectives while learning how to think critically about new possibilities through comparing different points of view.

In Transcript 8, Teacher Mara's persistency in giving affirmations to Kyrie which made him continuously express his doubtful responses mirrored a cooperative learning environment at the same time increasing the argumentative agency of Kyrie. Responses of Kyrie from Lines 2, 7, and 12 indicated confusions which were constantly answered by his classmates. However, despite taking turns in answering, his classmates were not able to clear his thoughts. But through Teacher Mara's revoicing and contingent dialogic prompts, he was not discouraged

to express his clarifications until he finally articulated the answer in Line 16. In this sample discussion, it is therefore implied that the revoicing strategy of Teacher Mara was effective in establishing the argumentative agency of Kyrie to continuously participate in the discussions until he was able to clear his own doubts. It is also important to note that the final answer to his question was not provided by Teacher Mara but was formed from the series of dialogic exchanges of reasoned arguments in the supportive statements of Lea, Gina, and Matthew, which commenced with the summative and supportive statement of Pearl in Line 13 to 15.

This dialogic scaffolding practice signifies a cooperative and effective support of responses which included questions, persistence in seeking clarificatory dialogues, and having opportunities to apply the help received from others. As a result, receiving and giving cognitive scaffolds were mediated by the learner's argumentative agency to construct meanings from the dialogic scaffolding prompts of their teacher and their peers. This dialogic scaffolding practice aligns with van der Linden and Renshaw (2004) who claimed that dialogic inquiry involves co-construction of knowledge in a collaborative learning environment involving "more mature and less mature participants engaged in semiotically mediated activity together" (p. 9).

***Providing reinforcement for a mutually contingent dialogic exercise.***

Analyses showed that Teacher Mara's dialogues were almost equally distributed across the three types (conceptual, analytical, reflective) with much emphasis on exploring prerequisite knowledge (21.96%) for the conceptual, presenting argumentative prompts (23.1%) for the analytical, and probing further (21.96%) for the reflective (Table 11; Figure 4) dialogues. It was noted during the observations that their discussions were mostly content-based but she mentioned in the interview that she implemented classroom argumentation by asking the students to debate as she encouraged them to "*present and defend their answers and ask other groups for counterarguments.*"

To dialogically scaffold the students in her Genetics class as shown in Transcript 7, her analytical dialogic prompt was used to elicit responses which brought them to the accomplishment of the lesson objective (i. e. importance of studying the mode of inheritance in humans). Based on the transcript, students mostly had short and unelaborated responses; but their dialogic exchanges with her contingent reinforcements built a series of active interaction which led them to their target content knowledge. For instance, when Diana said that learning the pattern of inheritance would be used to understand the inheritance of diseases (Line 3 to 4), instead of giving evaluative prompts, she recasted Diana’s response using a short reflective question, “*Do we really need to know this?*,” which provided opportunities for other students to participate; thus, increasing their responsibility to continue the discussion. As the students continued to give responses, she sustained the discussion by providing analytical cues (Line 7) which invited more participation. In response, the students, Linda and Kevin expressed their argumentative agencies in Lines 8 to 11 and their insights were acknowledged when Teacher Mara provided them with another cue to connect their lesson to their prior knowledge in Line 15 to 16.

*Transcript 7. Fragment of the Classroom Transcript on Lesson ‘Introduction to pattern of inheritance in humans’ (Lesson 2, 06-February-2018)*

<b>Speaker</b>	<b>Dialogic interactions</b>
1 <b>Teacher:</b>	What do you think is the main reason why we study the mode of inheritance for humans? ( <b>Ana; Increa pers</b> )
2	
3 Diana:	Ma’am it’s because we need to learn the mode transmission of diseases in humans. ( <b>Reas</b> )
4	
5 <b>Teacher:</b>	Do we really need to know this? ( <b>Refl; Increa pers</b> )
6 Leslie:	Yes Ma’am, so that we know how to be cautious about our health. ( <b>Reas</b> )
7 <b>Teacher:</b>	But it’s said that it’s already inherited; can we do something about it? ( <b>Ana; Cued eli</b> )
8 Linda:	Of course Ma’am...that’s why we need to determine our lifestyle. ( <b>Reas</b> )
9 Kevin:	Yes Ma’am, like my aunt, she has a diabetes...so her children are all cautious with their sugar intake coz they might have inherited the diabetes from their Mom. ( <b>Sup</b> )
10	
11	
12 <b>Teacher:</b>	So is there a way to know this pattern of inheritance? ( <b>Conc; Pri knowl</b> )
13 Francis:	Yes Ma’am, for the diseases, they usually go to the doctor and we know what are the diseases that can be hereditary. ( <b>Reas</b> )
14	
15 <b>Teacher:</b>	Ok, right...that brings us to know the different pattern of inheritance, say for example of Huntington’s disease. What do you have there in your homework? ( <b>Conc; Cued eli</b> )
16	

Based Transcript 7, it can be observed in the dialogic interactions that the students' responses were mostly simple claims. However, Teacher Mara's contingent dialogues tried to scaffold them to strengthen their claims using conceptual evidences or justifications. For instance, in Line 7, Teacher Mara's dialogue, "*But it's said that it's already inherited; can we do something about it?*" implied a counterargument to Leslie's response and was seeking for justifications which prompted Linda to express another reason in support of Leslie's statement. Kevin (Line 9 to 11) supplemented Leslie and Linda's claims with evidences from his direct experience about his Aunt's inherited cases of diabetes. As the interactions went on, Francis was able to gain the skill of expressing a claim and backing up with evidence with his response to Teacher Mara's contingent dialogue in Line 13 to 14. These series of dialogic interactions represented just-in-time task-relevant scaffolding which was established within a collaborative activity wherein conceptual dialogic interaction pushed the students to increase the expressions of their argumentative agency at the same time increasing their autonomy and accountability.

***Revoicing to increase students' backing and enhance their discursive identity.*** Analyses of the transcripts revealed that Teacher Mara's revoicing in the contingency phase was also instrumental to the co-generation of argumentative dispositions and created alignment of students' ideas towards consensus in the meaning making process. Through this dialogic scaffolding strategy, the class was able to engage in argumentation with significant number of either solicited or unsolicited dialogic exchanges. Oftentimes, Teacher Mara recapped students' responses, making them realize that their viewpoints had a significant contribution in the discussion.

This can be observed in their dialogic interactions in Transcript 8 when she allowed the conceptual dialogic exchanges among Kyrie, Lea, and Gina (Lines 2 to 5) and then recapped Lea's response (Line 6). Much as Kyrie's response was



not really related to the recapped statement, Matthew was prompted to clarify the doubts of Kyrie (Line 2 and Line 7) at the start of their dialogic exchanges which continued until after teacher Mara had already recapped Lea's response, a pre-supposed cue for him. Another contingent dialogue was prompted by Teacher Mara in Line 10 when she asked about the implications of the ratios obtained from the Punnet Square. However, it was still not clear for Kyrie but Teacher Mara was not tempted to give the explanations. Instead, she waited for other students to present the explanations to Kyrie's on-going clarifications as exemplified by Pearl when she presented a summary of the various viewpoints raised by her classmates (Lines 13 to 15) in response to the doubts of Kyrie about their lesson.

In this dialogic interaction, it can be observed that Teacher Mara was keen not to give evaluative prompts but instead, she continued to recap and bring in the doubts of the students (Kyrie in the case) to the argumentative discussions and allowed other students to clarify for them. Taking Kyrie's case, he was not hesitant in raising all his doubts as Teacher Mara continuously acknowledged his role in the discussions. Thus, his expression of argumentative agency was not suppressed but instead, he was more empowered to listen and present all his clarificatory dialogues which were readily answered by his more knowledgeable peers. Through this dialogic practice, the students' oral argumentative skills were extended through teacher-scaffolded dialogic prompts. Moreover, their discursive interactions orchestrated towards a sense making discourse activity from the meaningfully-related dialogic prompts which stimulated them to express more of their argumentative agency.

Transcript 8. *Fragment of the of the Classroom Transcript on Lesson 'Punnet Square' (Lesson 2, 07-02-2018)*

Speaker	Dialogic interactions
1 Teacher:	So what can you observe in the pedigree? <b>(Conc; Cued eli)</b>
2 Kyrie:	Ma'am, why is it that two offspring are healthy? <b>(Cla)</b>
3 Lea:	No, three are healthy. <b>(Eval)</b>
4 Gina:	Why do you say three are healthy? <b>(Chall)</b>
5 Lea:	The third offspring is the only carrier. So only one is affected! <b>(Cla)</b>
6 Teacher:	Ok, it was mentioned that only one is affected. <b>(Conc; Recap)</b>
7 Kyrie:	But the ratio is 1:2:1... so two should be carriers, right? <b>(Chall)</b>
8 Matthew:	Oh, my! It's your chance, don't mind your siblings. It does not depend on the number of your siblings. <b>(Reas)</b>
9	
10 Teacher:	What does the ratio tell us? <b>(Conc; Cued eli; Pri knowl)</b>
11 Pearl:	Yeah, it can be like you are not affected, a carrier, or affected. <b>(Reas)</b>
12 Kyrie:	But it's in the Punnet Square! <b>(Chall)</b>
13 Pearl:	Yes, it can be shown in the Punnet Square but don't mind the others. What if the parents only have one child? So, meaning, any of the three can be their daughter or their son. <b>(Cla)</b>
14	
15	
16 Kyrie:	Ok, got it.

In line with the principle of contingency as an element of scaffolding, Teacher Mara's flexible affirmations of her students' responses was able to successfully provoke them to participate in the dialogic interaction. Moreover, it became her dynamic assessment of their current level of understanding as they exercised their argumentative agency in response to her prompts. As she framed her questions to accommodate their contributions in alignment to their current level of cognition, students were facilitated to advance their collective thinking. This dynamic interplay of dialogues is consistent with Lyster and Ranta's (1997) concept of feedback-uptake wherein a teacher engages the students actively when she provided signals during recast of their utterances. Furthermore, prompts provided open elaboration of ideas and were free from corrective feedback to allow students to articulate their own conceptual understanding.

### 5.1.2 Teachers' dialogic scaffolding practices for students' expressions of argumentative agency in the fading phases

Similar to the results noted in the contingency phase of classroom discussions, teachers' varying levels of knowledge and belief systems on the nature of teaching and learning and on the nature and advantages of argumentation

affected their framing of their instructional approaches which eventually affected their dialogic scaffolding practices for students' expressions of argumentative agency in fading phases of classroom argumentation. Results of this study align with Bakhtin's (1982) pedagogical paradigm of dialogic teaching wherein teachers provided an open-space dialogue where students were allowed to challenge the ideas and opinions of their peers, teachers, and even their textbooks which resulted into greater negotiation of knowledge construction instead of the usual knowledge acquisition solely from their teachers (Alexander, 2008).

Two themes, each with two subthemes which were associated to the instructional approaches implemented were formulated in the fading phases. In the SSI-based classes, the Teacher Loida and Teacher Carlo's dialogic scaffolding practices resulted from their recognition of the students' scientific knowledge capitals. However, their recognition of students' knowledge capitals differed from each other due to their knowledge and belief systems. Teacher Loida expressed this through recontextualization of the classroom dynamics while Teacher Carlo expressed power distribution of his dialogic scaffolding prompts to encourage students to participate in the discursive process.

According Miller et al. (2018), in order to achieve desired results in science education, teachers should identify how their instructional approaches would result to students maximum and meaningful participation as they take on active roles in the learning process. In implementing classroom argumentation, it is therefore important that teachers create learning environments in which students recognize and understand the purpose of what they are doing (Kuhn, Kenyon, & Reiser, 2006). In this study, teachers' knowledge and belief systems on constructivist teaching and learning and on argumentation affected their instructional framing for their implementation of classroom argumentation. Thus, the differences on the teachers' instructional practices resulted to their differences on their dialogic scaffolding practices which were observed in the fading phases.

***Theme 1: Recognition of the students' scientific knowledge capitals for the SSI-based implementing teachers***

Bounded with the principles of constructivism, Teachers Loida and Carlo framed their Biology Elective classes towards classroom argumentation using socioscientific issues to drive the knowledge construction and reconstruction. As such, they were able to utilize the scientific knowledge capital of their students by recognizing the value of their previous content knowledge which served as the foundation for their classroom argumentation using socioscientific issues. Thus, in the fading phases of their argumentative discussions, students' ideas were constantly being recognized with their notions that the combination of the development of students' argumentative capacities which were established in the contingency phases of their discussions and the knowledge base that they possessed served as the foundation for their autonomy of expressing their argumentative agency in the fading phases.

Capitalizing on language as an essential tool in meaning making in the classroom, results of this study showed that as teachers recognized the value of joint knowledge construction, their dialogues were used to scaffold the discussion so that students were able to exercise their argumentative agencies during their participatory discussions. As their discussions progressed from the contingency to the fading phases of the scaffolding process, teachers' initial dialogic prompts led to productive peer dialogues with shared understanding of knowledge construction. As they prioritized facilitation, their dialogic prompts were used to increase students' expressions of argumentative agency when they tried to navigate towards acknowledging the background knowledge of the students which may drive them to respond for a joint meaning-making process. The various roles of the teachers' dialogic prompts in this study align with Mercer's (2000) claims that in order to probe students' thinking, their dialogues should be used to elicit further reasoned and elaborated responses. Specific to this study, the "increase students' perspective" dialogic prompts led to more interactions in the classroom and gave

the students the responsibility to achieve argumentative consensus, accomplish the objective of their lesson, and served to “break away from interaction patterns that are predominantly teacher-steered and based on recitation” (van der Veen, van Kruistum, & Michaels, 2015, p. 321).

According to Zeidler, Applebaum, and Sadler (2011), when SSI-approach to learning is properly implemented, it converts a classroom to a transformative learning environment where deep, moral, and interpersonal relationships and norms are facilitated and acquired. This is because in SSI-based classrooms, students’ plethoras of beliefs are elicited and in the process of dialogic exchange, their cultural backgrounds which affect their decision-making process and negotiation skills are exposed. In a dialogic environment using SSI-based approaches, students are prompted for active assertions of their beliefs but are dialogically scaffolded to become considerate of the feelings of others.

In this study, teachers recognized the knowledge capitals of students. However, their dialogic scaffolding prompts were grounded with a great deal on power distribution as they transact their knowledge construction through active assertions that was expected to progress in a shared understanding and valuing other’s perspectives. In the dialogic exchange of opinions, feedback was aimed for follow-up which encompasses various ways of eliciting responses such as clarification, evaluation, challenge, or support. Critic roles were expressed not leading to competitive state but recognition of the innate capacities for reasoning their knowledge capitals. These roles were utilized for re-articulating the meaning of previous statements so that they will be restated in a manner that were clear to everyone and with the possibility for eliciting further expressions of argumentative agency.

The pedagogic method of recognizing students’ knowledge capitals in the fading phase of dialogic scaffolding was based on the principles of reciprocal sharing of ideas and cumulative knowledge construction and understanding. In the

process of healthy persuasion, teachers examined students' views about the nature of their evidences especially when students perceived facts that were capable to refute others' claims. This called for the variety of teacher roles to act or model how ideas were formed through their expressions of valid claims which were supported with evidences. Mediated by language, the dynamic exchange in a dialogic environment in this study, attempted to slowly organize ideas with series of discursive actions. In the SSI-based classes, the complexity of the chosen topics were considerate of the students' knowledge capitals in such a way that abstract concepts are formed from basic or simple concepts rooting from either content or practical knowledge.

The first theme that was formulated to explain the teachers' dialogic scaffolding practices in the fading phases of their classes were associated to the teachers' who implemented classroom argumentation through SSI-based approach. In the SSI-based classes, the levels of teachers' knowledge and belief systems influenced their dialogic scaffolding by making them recognize the students' scientific knowledge capitals. Thus, in the case of Teacher Loida, she was able to recontextualize her classroom dynamics in order to deliberately implement classroom argumentation in her Biology Elective class. On the other hand, Teacher Carlo's recognition of students' scientific knowledge capitals was evident in his dialogic prompts with implied power distribution of discursive ideas to minimize the monotony of the discussion by either him or of a single student in class.

Table 11 presents the number of fading phases that occurred in the five lesson implementations in each class observed in this study. It can be noticed that Teachers Loida and Teacher Carlo who framed their classroom argumentation towards SSI-based approach had more fading phases in their classes compared to the content-based classes of Teachers Don and Teacher Mara. In the sample transcripts of their classroom argumentation in the fading phase, it can be inferred that as they recognized the scientific knowledge capitals of their students, they

were able to provide them with more independence to fuel their inquiry processes using their dialogic prompts. This aligns with the results on the majority of analytical and reflective dialogic prompts in terms of percentage of occurrence (Figure 4; Table 13) during their discussions.

Table 11. *Number of Fading Phases Observed the Five Lesson Discussions of each Class*

Instructional approach	Curriculum type	No. of Fading phases					Total
		Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	
SSI-based class	STE – Biology Elective	5	3	4	4	4	20
	Special Science – Biology Elective	5	5	4	4	5	23
Content-based class	GPHS- Regular Biology	4	2	3	3	2	14
	Special Science – Regular Biology	4	4	3	4	3	18

During the interview, both teachers expressed their recognition on the knowledge capitals of their students and that these should be elicited during classroom discussions so that the attention of the interactions would shift from them to the students. In fact, Teacher Loida said that, *“I believe that students can always engage in argumentation in class, they have opinions, they can talk... when a lot of students cannot, teachers should assist...”* This relates to her beliefs on the ideas of the sociocultural learning theory wherein, individuals have innate ideas based on their culture which can be shared through language. In the process of learning, teachers, as mentors to these students, can scaffold the students to share their ideas within their zone of proximal development—principles which align to the rationale of this study. Teacher Carlo’s recognition of students’ scientific knowledge capitals were also observed during the interview when he said that he

*“deliberately ask them (students) to share their opinions”* because he believed that they *“are equally opinionated as the others who continue to talk”* and that *“they just need a push.”*

***Recontextualization of the classroom dynamics.*** According to Akerblom and Lindahl (2017), to enhance students’ viewpoints in science learning, tasks should be relevant to both their personal and social lives. Therefore, for authentic learning, classroom tasks should be concerned with the values and meanings familiar to them with instructional approaches that bridge everyday knowledge and school knowledge by integrating socioscientific issues. In this study, Teacher Loida recontextualized the dynamics of her Biology Elective class and deliberately implemented classroom argumentation as her primary inquiry-based approach. As such, her dialogic scaffolding practices leveraged the students to express their argumentative agencies using socioscientific issues.

Having decided to implement SSI-based instructional approaches, it was clear that Teacher Loida framed the culture of knowledge construction towards encompassing content as well as developing the process skills of the students. With constructivist views, she did not view the students as individuals who come to class, sit, listen to her, and religiously took notes of all the important facts that she was telling them. Instead, she recontextualized the classroom environment wherein the dialogic exchange involved them with proper dialogic scaffolding prompts to allocate their argumentative agency. Moreover, she recontextualized the classroom dynamics by assigning her students tasks which required them of critical decisions on the issues which they need to establish using valid evidences from advanced reading and research tasks.

During the interview, Teacher Loida acknowledged the development of students’ classroom argumentation skills to be equally important with learning science content as they were able to practice their critical thinking skills when they were exposed to the direct application of the science concepts to their daily lives



(“What is the use of the content if the students are not able to apply those in their daily lives?”). In her lesson on cloning, the sample transcript below shows how their discussion progressed from the contingency to the fading phases because she did not provide evaluative responses that would possibly end their interactions. As such, their discussions were deepened when she provided more dialogic prompts which familiarized the students with the dynamic exchange of ideas, arguments, and explanations—a strategy that eliminated the usual Initiation-Response-Evaluation Pattern (IRE) in a traditional classroom.

Transcript 9 shows their discussions with majority of fading phases but with Teacher Loida’s dynamic assessment, alternating fading and contingency phases in their dialogic interactions were ensured. As student-student interactions were taking place, the minimal participation of Teacher Loida was observed when she tried to contingently appropriate the students’ statement such as in Line 8 when she said, “...It causes controversy nowadays! Why? What can be the reason?” This prompt statement encouraged responses from three students (David, Rem, and Ryan) with their interrelated arguments and counterarguments regarding the role of (Catholic) religion on the issue (Line 10 to 15).

Transcript 9. *Fragment of the Classroom Transcript on the Lesson on ‘Cloning’ (Lesson 2 Part 2, 15-01-2018)*

Dialogic Scaffolding Phase	Speaker	Dialogic interactions
Contingency	1 Teacher:	Ok, the union of the egg and sperm! So the early successful union forms the blastocyst! And it is said that this blastocyst consists of around 50-100 cells! And scientists claim that these embryonic stem cells, when taken out and they are pluripotent!
	2	Meaning, they can make all types of cells. That is why scientists are so interested in studying the embryonic stem cells! David, you are raising your hand! [ <b>Conc; App (contingency)</b> ]
	3	
	4	
	5	
	6	
	7	
Contingency	8 David:	Ma’am it causes controversy!
	9 Teacher:	Ok, very good! It is a cause controversy nowadays! Why? What can be the reason? [ <b>Ana; Tool comm (fading); Increa pers (contingency)</b> ]
Fading	10	
	11 David:	Ma’am coz they get those newly fertilized egg and they say its murder!
	12 Rem:	Yes Ma’am and the Catholic people say its violation to God!
	13 Ryan:	So better get it from non-Catholic people!

Transcript 9 (continued)

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	14	Rem:	Is it that easy? Even non-Catholic people are humans too! They
	15		have life like the Catholics!
Contingency	16	<b>Teacher:</b>	I have something to tell you...the blastocyst is still not a fetus, no
	17		life, no organs! Just a mass of 50-100 cells...it's not different
	18		from ordinary cells like red blood cells etc... [ <b>Conc; Ext cap</b>
			<b>(fading); Cued eli (contingency)</b> ]
	19	Ryan:	See, it can be taken. It's not yet murder! Murder is taking life!
	20	Rem:	But what if you allow it to just develop? It will become a baby,
	21		human being!
Fading	22	Ryan:	That's why take it while it's still a blastocyst! So, you will not
	23		commit murder!
	24	Rem:	What if you get married and that will happen to you? Like you
	25		plan to have a baby and they will take it, would you allow it?
	26	Ryan:	Of course not, but what I am telling is for those who wants to
	27		donate, it's ok... it's not murder!
	28	Diana:	But not all people will like that! Who would want to donate their
Contingency	29		baby?
	30	Kyrie:	And Ma'am, you will not know you are pregnant after one
			month!
Contingency	31	Cass:	What if for research purposes? Like they intentionally donate
	32		their blastocyst?
	33	Grace:	How is that? You cannot just take it! It should be done artificial!
Contingency	34	<b>Teacher:</b>	How is it done Grace? ( <b>Conc; Increa pers</b> )
	35	Grace:	Ma'am I read through IVF...Ma'am but the problem is, are there
	36		girls who want to donate their egg cells?
	37	<b>Teacher:</b>	Ok, yeah, are there girls who want to donate their egg cells to
	38		form a blastocyst? And take note, girls have limited number of
Contingency	39		egg cells. ( <b>Refl; App</b> )
	40	Grace:	Yes, Ma'am that is why we have menopause...so why do you
	41		consume your egg cells for research? What if you want to have a
	42		baby soon?
Contingency	43	<b>Teacher:</b>	Ok, so that's the controversy for it. But let me ask you, are you in
	44		favor of stem cell research by making blastocyst? ( <b>Refl; Increa</b>
			<b>pers</b> )
	45	Val:	Ma'am if maybe it will help in treatment of diseases, yes...

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To encourage more participation, she provided a background information when she said, *"I have something to tell you... the blastocyst is still not a fetus,"* which elicited nine students whose responses were with varying viewpoints (Line 17 to 33). In this interaction, the final student (Grace) directed a question to Teacher Loida but instead of readily giving the answer, she transferred back the responsibility to her to answer her own question which made her introduce another topic about egg cell donations (Line 35 to 36). Similar instances like these were observed in Teacher Loida's class so that as students expressed their opinions, related ideas continue to surface in the discussion leading her to formulate succeeding argumentative statements which stimulated further responses. For

instance, Grace responded by introducing the topic on in-vitro fertilization (IVF) based on her readings and through this information, Teacher Loida picked-up the IVF idea and used it to extend the discussion by addressing the questions to the female students in the class whether they would agree to donate their egg cells considering the limited number of egg cells throughout their lifetime as evidenced by the menopause (Line 40 to 42). Such discussions like these would alternate the contingency and fading phases in Teacher Loida's classroom as observed in this study.

In another lesson on stem cell therapy (Transcript 10), students played various roles in the discussion such as a challenger, a clarifier, an evaluator, a reasoner, and a support as they exercised their personal willingness to engage in the discussion as shown in the following transcript. Using Teacher Loida's dialogic prompts, students' counterarguments extended the discussion when they presented varied justifications for their claims. For instance, she scaffolded the discussion by providing an analytical argumentative prompt asking the students whether they are in favor of stem cell therapy in curing diabetes or not (Line 3 to 4). Ryan presented his challenging argument that he was not in favor for his reason that stem cell therapy is often used for beauty enhancements (Line 5 to 6). Justifying his argument with the advantage of using stem cell therapy as the fastest way to maintain youthful beauty, Chris opposed Ryan's argument with his evaluative statement by telling him the advantage of a fast procedure of making oneself young-looking (Line 7 to 8). However, Ryan insisted with his rebuttal statement saying that stem cell therapy should only be used "to cure diseases" and not for personal aesthetic purposes.

With just an initial argumentative prompt, Teacher Loida allowed intra-argumentation among the students. Thus, as the discussion continued, Ryan's idea was again opposed by Karen telling him that even when used to cure diseases, scientists might abuse the success by possibly making profit out of it (Lines 10 to

11). This evaluative statement was then supported by Rein and Stephen with their justifications that because of the profit-orientedness that can be linked to stem cell therapy, people might sacrifice their lives for financial purposes (Line 12 to 15). When Stephen opened the idea of donation, it was challenged by Dave with his justification that sperm and egg cell donations will not lead to death (Line 16).

Transcript 10. *Fragment of the Classroom Transcript on the Lesson ‘Stem Cell Therapy’ (Lesson 2 Part 2, 15-01-2018)*

Speaker	Dialogic interactions
1 Teacher:	Of course, that’s the ultimate reason...to treat diseases...like for example, those
2	suffering from diabetes; they can get embryonic stem cells and maybe grow
3	insulin-producing cells and transplant that to patients with diabetes. Are you in
4	favor? <b>(Ana; Increa pers)</b>
5 Ryan:	Ma’am I heard they are using it for beauty purposes...maybe I don’t like that!
6	Why do you want to be young-looking? <b>(Chall)</b>
7 Chris:	Why, don’t you like to be young-looking? So that you will no longer use anti-
8	aging products! It’s the fastest way to be young-looking! <b>(Eval)</b>
9 Ryan:	I think that’s not the purpose! Just use it to cure diseases and that’s good! <b>(Cla)</b>
10 Karen:	Ah it’s not good coz maybe those scientists will become rich from cells donated
11	to them. And those who donated will not know. <b>(Eval)</b>
12 Rein:	And it will be very expensive because it is very rare! <b>(Supp)</b>
13 Stephen:	Ma’am also, if other poor people will know that they become rich when they
14	donate embryonic stem cells, maybe there will be a lot of people who will donate
15	and many will die! <b>(Supp)</b>
16 Dave:	How can you die if they only get the egg and sperm cells? <b>(Chall)</b>
17 Stephen:	Ok!

Taking Teacher Loida’s recontextualized science classroom, it can be understood as her way of making her classroom a scientific community where novice individuals constructed and reconstructed their prior and tentative knowledge by means of persuasion and negotiation. In the process, she situated the negotiation of their meaning making of scientific knowledge within the depth of students’ prior and tentative knowledge with smooth flow of ideas grounded on her knowledge of students’ experiences. Thus, students were ushered to the understanding of science as comprising of events congruently reflected in everyday activities and can be negotiated through discourse. Based on the principles of the sociocultural theory and the zone of proximal development, Teacher Loida set the students’ learning environment and process within the range of their abilities that they can collaboratively do. Moreover, they were made to experience the

foundation of ‘doing’ science in a collective dialogic relationship where they achieved consensus from a persuasive but converging set of meaningful experiences.

***Power distribution of discursive ideas.*** One of the most important rules to negotiate students’ engagement in classroom discussion is the consideration of every student’s right to contribute and find his niche in the interaction plane. In this dialogic scaffolding practice of Teacher Carlo, students were not prevented from expressing themselves when he delayed their authoritative and evaluative prompts. Instead, every dialogically-scaffolded student’s response was viewed with sound acceptance of ideas. Moreover, with Teacher Carlo’s dialogic prompts, students were not left alone with their own discussions that might lead to classroom politics and that would exclude the ideas of certain students and thwart their inquisitive nature of appreciating science. Furthermore, through his dialogic scaffolding, students were allowed to construct and express their disparate ideas but became open for mutual negotiation of meanings.

In the power distribution of discursive roles, Teacher Carlo was not imposing to teach what students “need to know” based on his understanding which minimized the risk of students’ listening for the moment making information pass from one ear to another. Instead, together with his students, he slowly built their argumentative agency starting from the contingency phases, recognizing their prior knowledge which can be dialogically scaffolded. Thus, through this dialogic scaffolding practice in the fading phase, learning can be construed as something that is not reflective of a decree but concretized by the dynamic and dialogic exchange of ideas emanating from students which are constantly refined in the processes of persuasion and reconciliation.

Results of the analysis on the transcripts revealed that similar to the contingency phases, Teacher Carlo’s dialogic prompts were also dominantly analytical and reflective with short but provocative statements that encouraged

students to elaborate their opinions. As such, students were compelled to expound their justifications using related topics from different fields and perspectives to which their current topic can be linked to. These elaborations strengthened the quality of their arguments or counterarguments as well as their rebuttal statements. Transcript 11 shows the dialogic exchanges that happened in class which originated from Teacher Carlo's analytical dialogue about the issue on the 'ethicality of consent.'

Transcript 11. *Fragment of the Classroom Transcript on Lesson 'Consent for clinical trials' (Lesson 2, 05-02-2018)*

Speaker	Dialogic interactions
1 Teacher:	Ok, let me just clarify that Clinical Trials have varying stages, each is
2	crucial in establishing the efficacy, effectiveness, and safety of the
3	drug...now going back to the issue on the ethicality of consent? <b>(Ana; Tool comm)</b>
4 Claire:	Sir, I think it is more ethical if we give consent to both healthy and
5	unhealthy subjects. ...especially for human subjects Sir... we should be
6	humane in handling them coz they will play a big role in our research... <b>(Reas)</b>
7 Gina:	Yes, I agree...and say for example; our research will take a long time, it is
8	better to take care of our subjects so that they will remain with us. <b>(Sup)</b>
9 Ken:	Are you implying something, Gina? Take care of them so they will remain?
10	You mean to say, you bribe them? <b>(Chall)</b>
11 Gina:	No, what I mean is ensure their safety both the healthy and unhealthy
12	subjects. <b>(Reas)</b>
13 Roman:	But the issue here guys is the ethicality of consent. <b>(Chall)</b>
14 Jim:	But is it not enough that we ensure ethicality if we give consent? <b>(Eval)</b>
15 Gil:	Oh yeah...giving consent itself is considered ethical already... maybe the
16	issue is how deep must be their agreement. Like for example, are they
17	allowed to get out of the research, or are they allowed to demand some
18	payment? <b>(Sup)</b>
19 Yvette:	But all agreements should be in the consent form...or else you are
20	deceiving them...in fact you should also explain the agreements carefully
21	to them...that's ethics guys, oh well... <b>(Sup)</b>
22 Gil:	So in this case, all the ethical agreements were already clear. <b>(Sup)</b>
23 Matthew:	My question guys is, that when is it morally permissible to choose healthy
24	subjects for clinical trials? <b>(Chall)</b>
25 Louise:	Well, I think it is always morally permissible if we have the consent
26 Nina:	And we again surface the issue of consent... but what I can say is that,
27	researchers know the extent of their research...so so... <b>(Reas)</b>

In Transcript 11, when Teacher Carlo raised the issue on the ethicality of consent during Clinical trial stages, Claire's argument was that it must be ensured for both healthy and unhealthy subjects because scientists must still be "humane"

in doing research (Line 4 to 6). This was followed by a series of elaborated responses but as they expressed their argumentative agencies, they were keen to wait for others to finish in their expressions of their opinions. Moreover, it was noted during the observation that they recognized non-verbal cues making them ensure distributed chances to share in their dialogic inquiry.

Scenarios like these were observed across the lessons in Teacher Carlo's classes. It was evident that students became familiarized with the dynamics of classroom argumentation and with the few instances when Teacher Carlo prompted the class for their arguments, students infused various related topics which widened the topics for discussion and their expressions of their argumentative agency. Moreover, it can be observed that his dialogic prompt which served as a tool for communication to exist in class was open-ended; enough to elicit chains of argumentative statements from the students. In his dialogic prompt, it was noticed that he included wide areas such as efficacy, effectiveness, and safety when he raised the issue on the ethicality of consent (Lines 2 and 3). As such, this elicited chains of utterances from different students who shared diverse ideas with various expressions of argumentative agency based on his dialogic prompts. Normally, the related topics that students introduced in their arguments, counterarguments, and rebuttals became the dialogic scaffolds for each other which led them to a richer and a more meaningful interaction.

It can be interpreted that Teacher Carlo's recognition of students' scientific knowledge capital though power distribution of discursive ideas was a form of progressive inquiry that was initiated by dialogic prompts. In the process, as students were expected to share their own ideas from their prior knowledge and with skills gained from the contingency phases, the dialogic prompts were able to elicit students' intuitive conceptions and when they brought out their opinions, they were able to express their argumentative agency and at the same time, evaluate the coherence of their opinions and prompted by the succeeding lines of thought. As

they expressed their critical argumentative agencies, they were also able to widen their inquiry process when they generated subordinate questions that further elicited responses.

Much as Teacher Carlo and Teacher Loida both used SSI-based approaches, analysis on the classroom transcripts revealed that Teacher Carlo's students had better argumentative skills as observed with the types and quality of their responses to his dialogic prompts. As teacher Carlo allowed them to discuss on their own, their arguments, counter-arguments, and rebuttals which were rich with related topics and background knowledge served mostly to scaffolded further responses. In most of their discussions, the students did not rely on Teacher Carlo's new information; instead, Teacher Carlo used the related information that they brought in their discussions to probe them with further justifications. However, in those instances where students were not responsive enough, Teacher Carlo's analytical dialogic roles such as being a "devil's advocate" were enough to lengthen the discussions by encouraging them to expound the justifications to their arguments or counterarguments or to strengthen their rebuttals. The following segment of the transcript presents the dynamics of discussions in Teacher Carlo's class with various students' roles in the discussion process.

Transcript 12. *Fragment of the Classroom Transcript on Lesson 'Establishing Standards for Ethical Frameworks' (Lesson 1, 06-02-2018)*

Speaker	Dialogic interactions
1 Teacher:	So are you therefore in favor, Justin? <b>(Ana; Ext cap)</b>
2 Justin:	Sir no. Especially for humans. But for plants or animals, maybe I can. Sir
3	because humans are more important than animals or plants. We are concerned
4	with the life. <b>(Reas)</b>
5 Gil:	But animals and plants also have life. <b>(Eval)</b>
6 Ana:	I think, what Justin is trying to say is that we are playing God in the process.
7	Why do we not just hmmm, there is evolution anyway. As if we are cheating
8	the chance to decide our fate. <b>(Clall)</b>
9 Louise:	But the thing is we are created with brains and God gave that. We are using it
10	to improve ourselves. <b>(Chall)</b>
11 Albert:	It can be for plant and animal production... to increase the supply coz we are
12	growing in number, I mean people...so we have to increase supply of
13	food...well to avoid famine. <b>(Reas)</b>



### Transcript 12 (continued)

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14	Grace:	If it will be done for that purpose, maybe I can agree. For one, we cannot live if
15		there is shortage of food. People will die so I think it is better if we can
16		increase supply and if these will be mass produced, it will be cheaper for everyone. <b>(Supp)</b>
17	Carl:	Sir, for example, rice. In the Philippines, we are all rice eaters. That's why we
18		have the IRRI. To produce good quality rice.... like drought resistant or flood
19		resistant rice... <b>(Supp)</b>
20	Gil:	And we owe that to genetic engineering! So it's good guys! <b>(Chall)</b>
21	Justin:	Then again, these are plants. What's the case for humans? <b>(Chall)</b>
22	Gil:	Well it's gonna be for curing diseases guys! It's prolonging our lives so it's still
23		the same. <b>(Cla)</b>

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From the discussion reflected in Transcript 12, it can be observed that various related topics for their arguments, counter-arguments, or rebuttals were presented by the students which validated their justifications. Moreover, students' challenging arguments or counterarguments served as prompts which encouraged others to engage in the discussion. For instance, Louise' argument (Line 9 to 10) about the utilization of human intelligence for technological advancements prompted Albert to introduce the application of genetic engineering for plants and animals to avoid famine (Line 11 to 13). This then gave the idea for Grace to express her agreement with Albert that plant and animal production would be for increasing the supply of food for human consumption (Line 14 to 16). It can also be observed that the examples that Grace and Carl used in their supportive statements strengthened the quality of their own arguments and the previous arguments they supported.

Power distribution of students' ideas in the case of Teacher Carlo was his way to reorder and reconfigure the existing mode of knowledge acquisition and to retrofit his students' acquisition of concepts with the wide range of applications of biology from various fields. Recognizing the value of their scientific knowledge capitals in his dialogic prompts, their inquiry process allowed them to extend the dialogic interactions with collective ideas that mirrored the interwoven nature of social interaction in knowledge building. Moreover, through this, he was able to make the complex nature of scientific activity be experienced by the laypersons, in

this case, his students. As he acknowledged the value of their knowledge bases, his dialogic prompts were devoid of anticipating the closure of the application of every science topic to the confines of the classrooms and the compliance for grades. Prior to the start of the school year, he was already determined to implement a new practice with optimistic views leading to less challenges and obstacles on his part. Through his thoughtful prompts, the learning environment turned into dialogic teaching and learning which scaffolded the students during their exploration and debate of current scientific theories and applications.

As Teacher Loida and Carlo framed their Biology Elective classes towards SSI-based teaching method for classroom argumentation, their oral tasks were inclined to what count as learning science, understand the concepts within a discipline, as well as what count as important process skills in the pursuit of learning. In this sense, students perceived science as a body of knowledge that can be explored through scientific practices such as argumentation resulting to their recognition of science education as a pursuit of knowledge leading to desirable outcomes in terms of content knowledge and process skills. Influenced by their constructivist and informed beliefs on the nature of teaching and learning and on the nature and advantages of classroom argumentation, their provisions for dialogic scaffolding practices specific to the nature of their students in the class stimulated the students' sustained motivations to participate in the discussions. As such, as they progressed towards the fading phases through the dynamic assessment of their expressions of argumentative agency in the contingency phases, their discursive exchange became hints for the teachers to upgrade their knowledge capitals.

***Theme 2: Sensitivity to students' willingness to participate in the dialogic exchange for the content-based implementing teachers***

Creating conditions for students' participation in the discussion was so much aligned to the type of learning environment they are exposed to through their teacher's approaches to teaching and learning, and the teachers' acknowledgement,

accommodation, and responses to their diverse needs. In this study, just like the teachers who framed their instructional approaches for classroom argumentation towards SSI-based approaches (Teachers Loida and Carlo), these were equally addressed by the teachers (Teachers Don and Mara) in the content-based Regular Biology classes. Their framing of instructional approaches was affected by their varying levels of knowledge and belief systems. Based on Table 12 Teacher Don possessed transitional and intermediary levels while Teacher Mara possessed constructivist and informed levels on the nature of teaching and learning and on the nature and advantages of classroom argumentation. These varying levels of knowledge and belief systems thus influenced their enactment and dialogic scaffolding practices for students' expressions of argumentative agency in the fading phases.

Compared to the SSI-based classes, it can be observed in Table 11 that these content-based classes had lesser fading phases during their classroom argumentation. This can also be attributed to the majority of conceptual questions that the teachers used as dialogic prompts. As students responded with conceptual answers composed of factual and canonical scientific ideas, their expressions of argumentative roles were mostly constructive composed of simple reasons and supportive statements which did not elicit further responses. However, because of their desire to extend and provide instances for student' expressions of argumentative agency using reflective dialogic prompts, their contingent discussions progressed into significant number of healthy fading phases during the argumentative discussions.

It is however important to stress that the dialogic scaffolding practices of Teacher Don and Teacher Mara in the fading phases of their discussions were implemented as their ways to express sensitivity to their students' willingness for dialogic involvement. Nevertheless, their varying levels of knowledge and belief systems influenced their dialogic scaffolding practices to express their sensitivity to

students' willingness to participate in the argumentative discussions. Teacher Don particularly was focused on his responsiveness to and raising of students' scientific cognitive demands while Teacher Mara's expression of sensitivity to the students' willingness to participate was through provision of gradual autonomy for learner uptake of the contingent dialogues and fading prompts.

In the case of Teacher Don, his optimism and his desire to become a constructivist teacher in Biology made him attend to the cognitive demands of his students. On the other hand, Teacher Mara intentionally enacted classroom argumentation to raise the cognitive demands of her students with her beliefs that *"it is helpful coz the students think deeper and they are able to express themselves... students become more responsible on their learning."* Their dialogic prompts were mostly conceptual and reflective but were not the reasons to progress towards traditional teaching; thus minimizing the IRE pattern of interaction. Key to these dialogic scaffolding is the belief that students come to school and were willing to participate in the discussions and their willingness to do so was a product of their prior knowledge which can be activated through dialogic scaffolding.

***Responsiveness to and raising of students' scientific cognitive demands.***

According to Kisa and Stein (2015), in order to arrest the decline of cognitive demands in science classroom, teachers must shift their beliefs on the teaching and learning process to engage students' thinking and recognize their efforts of sensemaking in order to raise their levels of thinking and reasoning. In this study, Teacher Don shifted his classroom dynamics which accommodated inquiry learning and scaffolded his students to accomplish the construction of scientific knowledge through argumentation. Moreover, the dominance of his reflective dialogic prompts in the fading phases indicated his recognition of the students' ability to participate to widen their own perspectives on the applications of their science content knowledge. Thus, his reflective dialogic prompts were mostly connected to their daily lives or to previous content knowledge making their

science learning process holistic and devoid of the “patchy” ideas. As previous knowledge became motivational ideas and dialogic prompts for students, their contingent discussions were able to progress towards the fading phases where students’ expressions of argumentative agency were more evident.

In order to express his responsiveness, he continuously validated students’ claims through his reflective and conceptual dialogic prompts which were encompassing of the multi-dimensional aspects of knowledge that can be developed among his students in a sound learning environment. Success in the knowledge formation among his students can be observed which resulted from his dialogic prompts through their varied ideas that were brought into the discussions. Moreover, as he was conscious on the intellectual capacities of his students, he constantly provided them with enough time to process previous statements allowing them to grasp the meaning of ideas so that succeeding responses would slowly develop from layman’s terms to scientific ones. As such students accomplished their lesson objectives direct from their utterances which were products of his dialogic scaffolding prompts.

In Transcript 13, it can be observed that he allowed them to interact with each other using his initial prompts that progressed from the contingency phase. In the transcript, his initial reflective dialogue was used to scaffold and increase the students’ expression of their argumentative agencies. In the dialogue below, they were discussing about the importance of grouping organisms that were previously done by scientists who established the Kingdom classification system. The first response from Martin to simply group the organisms as plants and animals (Line 5) was challenged by Dondie when he said that bacteria and viruses cannot be classified as plants or animals (Line 6). However, including viruses as organism was again challenged by Leanne saying that viruses are not organisms (Line 7). Moreover, Vince challenged Martin’s argument with his counterargument which raised the issue regarding the diversity of plants and animals (Line 8). These

arguments and counterarguments were supported by Rem when she explained the possibility to simplify the classification if ever they accept Martin's argument. Regardless of Rem's justification and explanation, Randy still insisted that having plants and animals is still a broad classification which supported the earlier counterargument of Vince. Moreover, Kevin, also resurfaced the earlier argument of Dondie to consider bacteria as another group of organisms in the classification system. With these arguments, and counterarguments, Rem tried to establish a consensus on the possibility to have three classification systems namely plants, animals, and bacteria (Line 14).

Transcript 13. *Fragment of the Classroom Transcript on Lesson 'Classification of Living Things' (Lesson 1 Part 2, 15-01-2018)*

Speaker	Dialogic interactions
1 Teacher:	Ok, try to imagine if you are the one to group all the living things on earth.
2	Can you do it? Actually, it was already grouped. But try to imagine if you are
3	the one to do it. Can you do it? Or try to imagine if you were the early
4	scientists, how difficult it is. <b>(Refl; Tool comm)</b>
5 Martin:	Maybe plants and animals!
6 Dondie:	How about bacteria and virus? <b>(Chall)</b>
7 Leanne:	Virus is not a living thing! <b>(Chall)</b>
8 Vince:	It's not only plants and animals... there are so many... <b>(Eval)</b>
9 Rem:	Or it can be plants and animals but regroup them more. For example, animals
10	which have legs and not, animals which can fly etc. Or plants which live in
11	water, in air, or in soil...maybe like that... <b>(Clar)</b>
12 Randy:	But it's too broad! <b>(Chall)</b>
13 Kevin:	And how about bacteria? <b>(Supp)</b>
14 Rem:	Ok, so make it three plants, animals, and bacteria... <b>(Cla)</b>

In Transcript 13, the reflective dialogic prompt of Teacher Don (Lines 1 to 4) which asked students to imagine themselves grouping all living things on earth was a motivational statement which made the students think about the various ways they can group organisms. With prior knowledge on bacteria and viruses, Dondie was able to express his critic argumentative agency which prompted Leanne to counterargue and challenge his statement about virus as a living thing. These discussions progressed into more unsolicited responses and in the process, various types of argumentative agency were expressed. From the dialogic prompt,

it can be observed that the simple reflective statement prompted the students to respond in varying levels of cognitive complexity from simple recall of biodiversity which progressed into their process skills of classifying, explaining, and justifying their classification schemes.

In another classroom episode, there were few students who participated in the fading phase; but Teacher Don's dialogic prompts tried to extend the discussion leading to alternating contingency and fading phases. In Transcript 14, he began asking the Group 2 students about the similarities between plants and the autotrophic protists. With a conceptual dialogue, students (Rina, Jim, Bryan, Lian, and Bing) enumerated the characteristics of plants which can also be observed in autotrophic protists. In a traditional classroom, these types of response would normally end the discussion but in Teacher Don's case, he tried to encourage participation and increase the capacities of the students to engage in argumentation by recapitulating and appropriating their dialogues such as Bing's statement about the habitat of autotrophic protists. Through this, two students (Renz and Michelle) were able to give counterargumentative responses which elicited a clarification response from Bryan. The discussion was again extended when he recasted Bryan's clarifying response by providing them with a reflective dialogue about the role of autotrophic protists in the survival of fish. This led to another fading phase which triggered argumentation about feeding patterns of fish. The transcript shows how supportive he was in providing his students the opportunities to continue the discussion when he asked the importance of plant-like protists. Linda (Line 21) was then prompted to respond with her agreement to the question and justified her claims using a summary of the previous series of arguments, counterarguments, and rebuttals of her classmates making her establish the consensus and accomplish the learning objective. Scenarios like this were observed in Teacher Don's class across the lessons observed in this study.

Transcript 14. *Fragment of the Classroom Transcript on Lesson 'Kingdom Protista' (Lesson 2 Part 2, 15-01-2018)*

<b>Dialogic Scaffolding Phase</b>	<b>Speaker</b>	<b>Dialogic interactions</b>
Contingency	1 <b>Teacher:</b>	In what way are they similar? Group 2! ( <b>Conc; Tool comm</b> )
	2 Rina:	Sir the plant-like protists have chlorophyll.
	3 Jim:	They can make their own food.
Fading	4 Bryan:	They have cell walls!
	5 Lian:	They have root-like...like plants!
Contingency	6 Bing:	Sir, they live in the oceans.
	7 <b>Teacher:</b>	Ok, we can find them in oceans...why? ( <b>Refl; Recap; App</b> )
	8 Renz:	They feed the fishes...
Fading	9 Michelle:	What? They feed the fishes? Haha! Fishes eat them!
	10 Renz:	Ok...it's just the same.
	11 Michelle:	How can they feed the fishes? They have no hands!
	12 Bryan:	Fishes feed on them!
	13 Renz:	Ok, I'm wrong!
Contingency	14 <b>Teacher:</b>	Ok, so fishes feed on them. So without them, will there be food for fishes? [ <b>Conc; Recast; (contingency) [Cued eli (contingency) Acc lear obj (fading)]</b> ]
	15 Claire:	No Sir! So fishes will die!
Fading	16 Rina:	So if there will be no algae, fishes will eat other fishes!
	17 Denver:	But not all fishes can feed on fishes. There are fishes who eat only algae! So they will die.
	18 Dave:	So if they die, there will be no fish for the big fish!
	19 Linda:	What? No fish for the big fish? No food for the big fish!
Contingency	20 <b>Teacher:</b>	So are they important? [ <b>Refl; Increa pers (contingency); Ext cap (fading)]</b> ]
	21 Linda:	Yes Sir, coz if the small fish will die, the big fish will not have food. And they will eat their fellow big fishes... and there will be less fish in the ocean. Only big fish who survive!
	22 <b>Teacher:</b>	Ok, what do we call those food relationships? Or eating relationships? Yes Diana! [ <b>Conc; Pri knowl (contingency); Acc lear obj (fading)]</b> ]
Contingency	23 Linda:	Yes Sir, coz if the small fish will die, the big fish will not have food. And they will eat their fellow big fishes... and there will be less fish in the ocean. Only big fish who survive!
	24 <b>Teacher:</b>	Ok, what do we call those food relationships? Or eating relationships? Yes Diana! [ <b>Conc; Pri knowl (contingency); Acc lear obj (fading)]</b> ]
	25 Diana:	Food chain!

Discussions similar to Transcript 14 were frequently observed across the lessons observed from Teacher Don's class. It can be noted that there were less elaborations on the students' arguments, counterarguments, and rebuttals since they barely related their lesson topic to other concepts that may be used as prompts for other students to formulate their counterarguments. It can also be noticed that students showed less argumentative agency (mostly as challengers) which resulted to less interactions. As they attempted to build commonality in their meaning making process, Teacher Don's dialogic scaffolding was an essential method that enabled further inquiry and understanding. From the socioconstructivist theory, as they tried to sustain the discussions, they acted and reacted on ideas and meanings



with enough negotiation as the teacher facilitated the building of new knowledge from prior understandings. To express his responsiveness to and to raise his students' cognitive demands, Teacher Don did not limit his content-based classroom purely on biology concepts but through his dialogic scaffolding prompts, he was able to expand the content learning to social knowledge, science process skills, and even made connections to students' prior knowledge.

*Provision for gradual autonomy and learner uptake of the dialogic prompts.* Similar content-based lessons with 'objective' responses were observed from Teacher Mara's class. However, with instances when students' dialogues scaffolded the succeeding statements for others, Teacher Mara gave them the opportunities to discuss by themselves and resolve each of their own arguments. In these instances, Teacher Mara withdrew herself from the discussions and allowed the students to gain control over their discussions which eventually led to their autonomy that triggered their own dialogic exchanges in the fading phases. Moreover, these were also the opportunities for students to uptake their knowledge building process from the series of responses. Learner uptake was used as provision of time for students to think over the previous chains of reasons that were shared in the discussion so that they were able to compare those to their personal knowledge.

The provision for uptake in Teacher Mara's classes was her way to make the students assess the knowledge that is brought into the discussion by identifying the gaps between what they currently know and the new knowledge. As such, in the fading phases, as the students expressed both the constructive and critic types of argumentative agency, the students tried to incorporate, construct, and reconstruct knowledge. Students freely expressed themselves even without the participation of Teacher Mara in the discussion. This signifies how important Teacher Mara's initial dialogic prompts in inviting participation. Moreover, it was noted that as she avoided evaluative responses, students were allowed to talk, initiate collective

consensus by themselves, and obtained the right answers to their queries.

Guided by her dialogues, students in the fading phase of her argumentative classroom were scaffolded with multiple feedbacks such as comments, questions, or related information which were not provisional of the direct answers but required others to assemble the meaning in a negotiated discourse. These were usually in the form of rundown statements encompassing of previous related ideas which progressed from the contingency phases to the fading phases. This may either be in the form of reconciliation statements which were content-based or consensual decisions of issues presented to them which were dialogically scaffolded through reflective questions or scenarios.

For instance, in Transcript 15, Teacher Mara simply asked Group 1 for their justification on their pedigree analysis. Mina' argument for the pattern of inheritance to be X-linked (Line 5) elicited a series of violent reactions from her classmates with all their justifications for their claims (Line 4 to 15). These justifications led Teacher Mara to recast and recap their resolutions (Line 16 to 17), but she asked another question that led Ryan to realize that there was a mistake in the pedigree problem (Line 19). Instead of providing the final resolution, she gave the students the responsibility to correct the pedigree and further asked justifications until they reached the final resolution with Angelie's synopsis of all the salient points that her classmates provided to correct the pedigree problem (Line 23 to 26).

Transcript 15. *Fragment of the Classroom Transcript on the Problem-solving Activity on 'Pedigree Analysis' (Lesson 3, 09-02-2018)*

<b>Dialogic Scaffolding Phase</b>	<b>Speaker</b>	<b>Dialogic interactions</b>
Contingency	1 <b>Teacher:</b>	Ok, who has another answer? Group 1, can you share your analysis and explain? ( <b>Conc; Incea pers</b> )
	2	
Fading	3 Mina:	Ma'am, we think it's x-linked! ( <b>Reas</b> )
	4 Charm:	Is it x-linked dominant or recessive? ( <b>Eval</b> )
	5 Mina:	I think its x-linked dominant! ( <b>Reas</b> )
	6 Carl:	Why is it x-linked dominant? ( <b>Chall</b> )
	7 Mina:	Because females have it! ( <b>Reas</b> )
	8 Matthew:	It skipped in the generation 4. ( <b>Sup</b> )

Transcript 15 (continued)

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	9	George:	And the father is the carrier! So how come the sons have it? <b>(Sup)</b>
	10	Linda:	Oh yeah! X-linked cannot be passed on from fathers to sons! <b>(Sup)</b>
Fading	11	Luis:	Oh wait, it can be! <b>(Eval)</b>
	12	Alvin:	How come Luis? Do you have three X-alleles? <b>(Chall)</b>
	13	Luis:	Oh, uh! Yeah! No, it cannot be X-linked dominant! <b>(Eval)</b>
	14	Renan:	It cannot be Y-linked coz females also has it! What is it, Ma'am?
	15		So hard! <b>(Eval)</b>
Contingency	16	<b>Teacher:</b>	Ok, it cannot be autosomal dominant, it cannot be X-linked dominant, it cannot be Y-linked. So what is it? <b>(Ana; Recast; Recap)</b>
	17		
	18	Grace:	Ma'am, it cannot be x-linked recessive! <b>(Sup)</b>
	19	Ryan:	Ma'am, there is a mistake in the pedigree! <b>(Chall)</b>
Contingency	20	<b>Teacher:</b>	So how can we correct the pedigree then? <b>(Conc; Increa pers)</b>
	21	Angelie:	Ma'am, both parents should be recessive. <b>(Reas)</b>
Contingency	22	<b>Teacher:</b>	Explain your answer, Angelie! <b>(Ana; Increa pers)</b>
	23	Angelie:	Ok, so autosomal recessive...in the Generation 2, even if both parents are recessive, males and females can have the chance to have it. Same in generation 3...and in Generation 4, it did not show in the offspring of child 4. <b>(Reas)</b>
	24		
	25		
	26		

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Similar to the analysis of classroom scenarios in the earlier sections, the framing for content-based argumentation which occurred in Teacher Mara's class affected her dialogic scaffolding practices which resulted to students' expressions of their argumentative agency. Through her dialogic scaffolding, the class was able to engage in classroom argumentation with significant number of either solicited or unsolicited dialogic exchanges. Solicited responses in the fading phase were however observed to be mostly accomplished by the students since their own dialogic responses triggered others to express their argumentative agency with their critic or constructive roles. When Teacher Mara participated in the solicitation of responses, it can be observed that her dialogic prompts were mostly increasing the perspectives of the students by transferring them the responsibility to accomplish the lesson objectives by formulating and articulating their responses to their own questions or to answer other's questions such as in Line 22 in Transcript 15 and in Line 10 of Transcript 16.

At some instances such as in Line 16 in Transcript 15, she noted the critical points of students' responses and in a form of cumulative analytical dialogic prompt, she formulated follow-up questions that triggered another chain of

responses containing both constructive and critic dialogic roles of the students as expressions of their argumentative agency. Oftentimes, Teacher Mara did not provide immediate evaluative responses but instead, she tried to mostly recapitulate students' responses and increased their perspectives in handling the discussion until they achieved the objective of their lesson. Sample Transcript 16 below shows how the two fading episodes were prompted by Teacher Mara's analytical and reflective dialogues for their discussion on the topic X-linked pattern of inheritance.

Transcript 16. *Fragment of the Classroom Transcript on the Lesson on 'X-linked Pattern of Inheritance' (Lesson 4; 07-02-2018)*

Dialogic scaffolding phase	Speaker	Dialogic interactions
Contingency	1 Teacher:	Why only the daughters? <b>(Conc; Increa pers)</b>
	2 Alvin:	Only the daughters coz daughters have two X-chromosomes! <b>(Reas)</b>
Fading	3 Albert:	And of course, the father always give his Y-chromosome to his sons! He is the only source! <b>(Sup)</b>
	4	
	5 Angelie:	So if the father is affected, all his daughter are at risk! <b>(Cla)</b>
	6 Mina:	If the mother is also affected, there is higher chance! OMG! <b>(Cla)</b>
	7 Luis:	Ok, lucky us, we only have one X-chromosome! And even if our Dads have it, we cannot have it! Haha! Poor girls! <b>(Eval)</b>
Contingency	8	
	9 Linda:	But if guys have the allele, they are definitely affected, Ma'am? <b>(Eval)</b>
	10	
	11 <b>Teacher:</b>	Who can answer that? <b>(Conc; Increa pers)</b>
Fading	12 Isabel:	Of course, they will, coz they only have one X-chromosome. And it's dominant so they will be affected. <b>(Cla)</b>
	13	
	14 Arlene:	And they will have 100% chance to pass that to their daughters. You know, law of segregation! <b>(Sup)</b>
	15	
	16 Renan:	Of course, even males can have the disease! <b>(Sup)</b>
	17 Pearl:	Yeah of course males can have it but from their mothers only! <b>(Cla)</b>
	18 Gina:	If you are a male, you 100% got your Y-chromosome from your father. So even if your father has the disease, it can only be passed on to the daughters! <b>(Reas)</b>
	19	
	20	
	21 Claire:	But which is more dangerous? I think for males! Coz they have no other good X-allele unlike the girls! <b>(Cla; Reas)</b>
22		

In Transcript 16, Teacher Mara's initial conceptual dialogue elicited a series of students' responses, each of them expressing their own argumentative agency in their dialogic exchanges. From the transcript, the discussion was about establishing a consensus on the X-linked pattern of inheritance. Teacher Mara's dialogic prompt was asking for an elaboration as to why male parents usually pass

their X-chromosome to only their daughters. Alvin's initial response was that it is imperative that females receive one X-chromosome from each of their parents (Line 2). This was supported by Albert with his argument that the Y-chromosome that the male parent has to be always passed on to the male offspring (Line 3 to 4). The discussion continued with Angelie's clarification dialogue on the risk associated to the inheritance of X-linked diseases (Line 5) and this was supported by Mina with an exclamation that females who happened to inherit the disease from both male and female affected parents put them at higher risks (Line 6). Luis further expressed an evaluative dialogue as a summary for their discussion.

Based on the flow of discussions, it can be assumed that the class was almost at a consensus, but Linda's clarification (Line 9 to 10) initiated another round of discussion towards the fading phase. Teacher Mara, instead of providing an answer, asked others for their opinions (Line 11). This prompted Isabel to clarify that with an X-linked dominant disease, one copy of the allele is enough for the males to be affected (Line 11 to 12). Moreover, Arlene, Renan, and Pearl expressed their supportive and explanatory statements about the X-linked pattern of inheritance. More explanatory reasons were provided by Gina reiterating that male parents never pass their X-chromosome to their sons, so the inheritance is from male parents to female offspring (Line 18 to 20). Further information was provided on the risk associated to the inheritance of this disease when Claire said that, with the dominance of the trait, having at least one allele would subject those affected individuals to risks. Moreover, she pointed out that male offspring's inheritance of the disease from their female parents would subject them to more risks due to the absence of another unaffected allele that would minimize the expression of the disease (Line 21 to 22).

In traditional classrooms, content-based discussions were usually filled with pre-emptive questions that initiated students' responses. Mostly, these were teacher-initiated in a form of objective questions which target one and specific

answer from the students. However, in Teacher Mara's class, though these types of questions were observed in the initial stages when their discussions were trying to introduce the unfamiliar scientific knowledge to the students, she allowed gradual autonomy for the students to assume the responsibility of achieving the objectives of their lessons by providing them time to uptake and make connections between the prior scientific ideas and the new ideas introduced in their current lessons. Learners' uptake usually resulted from critical evaluation of previous responses to arrive at their own conceptual understanding during episodes of unsolicited responses. Aside from the students' benefit from the uptake, Teacher Mara also benefited when she used the students' responses to formulate another dialogic prompt. It was in a way, her form of giving feedback to structure the series of student-initiated interaction and thus, making students pay attention to the main focus of their lessons.

Much as her corrective feedback focused on the critical points of the lesson, it was not implying a gap on the development of scientific understanding. Her corrective feedbacks were usually indicative of re-emphasis to the significant learning points associated to the current topic when the discussions were already shifting away from the lesson focus. Thus, analytical and reflective dialogic prompts allowed learners to have a "moment of uptake" in order to refocus their attention on the significant learning points and to connect the new concepts either to their prior knowledge when the feedbacks were conceptual dialogic prompts or apply them to their daily lives when the feedbacks were reflective dialogic prompts.

In Teacher Don and Teacher Mara's dialogic scaffolding practices in the fading phases, their sensitivity to their students' willingness to participate in the dialogic discussions established an argumentative dialogic environment where they became responsive on the roles of the students during their expressions of their argumentative agency in the dialogic exchange. Moreover, through their sensitivity to the innate capacity of their students to be involved in the argumentative

discussions, their contingent dialogic scaffolding prompts progressed from the contingency phases of the discussion to the fading phases to allow gradual autonomy for the students to take over the argumentative discussion. As they progressed to the fading phases, the occurrence of their reflective dialogic prompts were also evident which contained more open-ended questions which stimulated the students to respond from a wider perspective with either conceptual focus from prior content knowledge or social application of their lessons.

Teacher Don and Teacher Mara framed their biology classes to be content-based but their decisions to conduct their classes through argumentation established the dynamic interplay of their dialogic scaffolding practices and the students' expressions of their argumentative agency. Their learning environment became constructive and participatory which fostered a deeper and exploratory understanding and construction of scientific knowledge. Students were enabled to communicate their levels of understanding based on their prior knowledge which was readily reconstructed through argumentation. This aligns to Stein, Grover, and Henningsen (1996) who claimed that high level of cognitive demands are products of teachers' alignment of their instruction towards discursive problem solving.

Thus, despite the content-based focus of their science learning environment, their learning processes yielded three important aspects of classroom learning: communication and negotiation of prior knowledge, establishment and maintenance of social relationships, refinement of understanding scientific knowledge, and development of students' identity. Teachers' dialogic prompts served as social scaffolding which anticipated the participation of the students as they process information to construct and reconstruct scientific knowledge. It is therefore necessary that teachers scaffold an open and interactive argumentation where interactions vary in terms of depth so that students gain the responsibility to be more involved with increasing cognitive demands in the process of making conjectures and evaluating evidences.

## **5.2. Teachers' knowledge and belief on the nature of teaching and learning and on the nature and advantages of classroom argumentation**

**SSI-based implementing teachers.** The study involved four teachers, each of them implemented different types of DepEd and DOST basic biology education curriculum in the Philippines. Two teachers namely Teacher Loida and Teacher Carlo implemented the Biology Elective classes from each curriculum. Analyses showed that these teachers possessed the highest levels of knowledge and belief systems which were acquired from and/or products of experienced-based knowledge (Teacher Loida) and theoretical knowledge (Teacher Carlo). Thus, according to them, they intentionally framed their instructional approaches for their Biology Elective classes towards SSI-based approach as they planned to implement classroom argumentation. They had similar regard to the effectiveness of classroom argumentation as an inquiry-based practice in science education. However, the slight difference in their levels of knowledge and belief systems influenced the differences of their dialogic scaffolding practices in both the contingency and fading phases.

**Teacher Loida.** Analysis on the demographic data showed that Teacher Loida was the most experienced among the teacher participants having 35 years of teaching and exposure to more or less 20 various inquiry-based teaching and learning seminar-workshops and trainings including classroom argumentation (Table 1). Based on her overall responses on the survey (TBTLQ), she had a constructivist view towards teaching and learning particularly on her teaching strategies (Figure 2). She also held a constructivist view on classroom management but traditional in terms of how she dealt with the parents of her students (Table 12).

During the interview, Teacher Loida also regarded herself as a facilitator of learning. Having these views, she put high regard on the abilities of her students (*"I want to become the facilitator. You know, you become more effective if you*



*allow students to take responsibility on their learning...they become empowered”).* In their classroom discussions, she usually acknowledged her students’ efforts which served as motivation for them to achieve more. In fact, this was also her way to assess how varied her students’ learning abilities were and her way to assess their prior knowledge and efforts for their subject (*“there will always be students who are wide readers... they extend their efforts...So it’s better to acknowledge them so that they will keep on doing the same. So from there, I can gauge how much they have gone through their research”).*

With Teacher Loida’s constructivist beliefs, experiences, and various exposures to inquiry-based instruction and argumentation, these played major impacts on her implementation of classroom argumentation. With her constructivist views, she was able to act as a facilitator and results of the interview showed that she prioritized collaborative understanding of concepts through argumentation rather than focusing on the pre-determined sequences of instructions written in the curriculum materials. Moreover, through her dialogic scaffolding, students became active participants as they constructed their own knowledge in a contextualized manner. Through her dialogues, students demonstrated enthusiasm in the subject matter and with peer negotiations, they were able to clear out their misconceptions to achieve unified concepts essential to their learning processes. As she encouraged the students to relate their classroom topics to real-life scenarios, they became aware of the direct implications of their scientific knowledge and they took the responsibility to build the connections of their science topics to their daily lives.

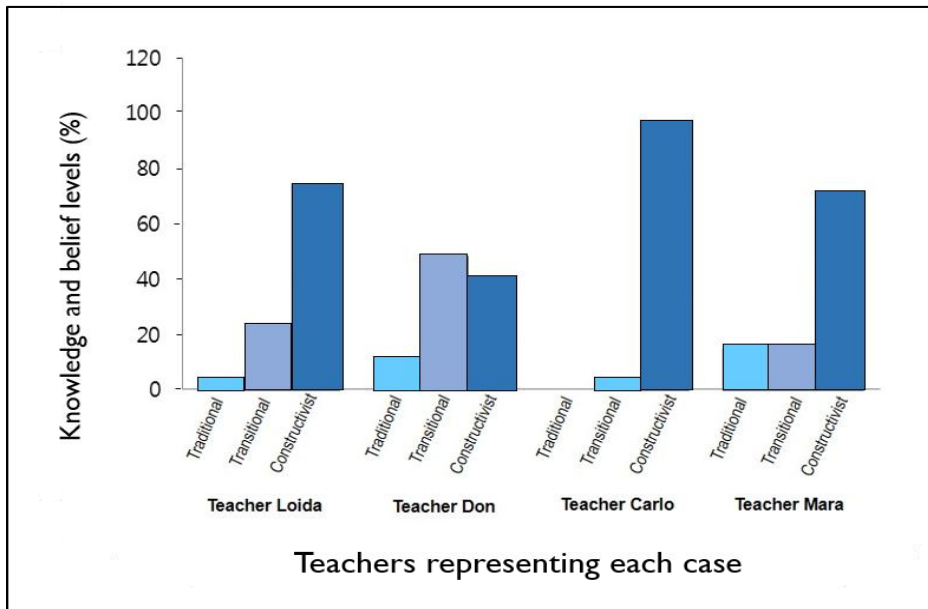
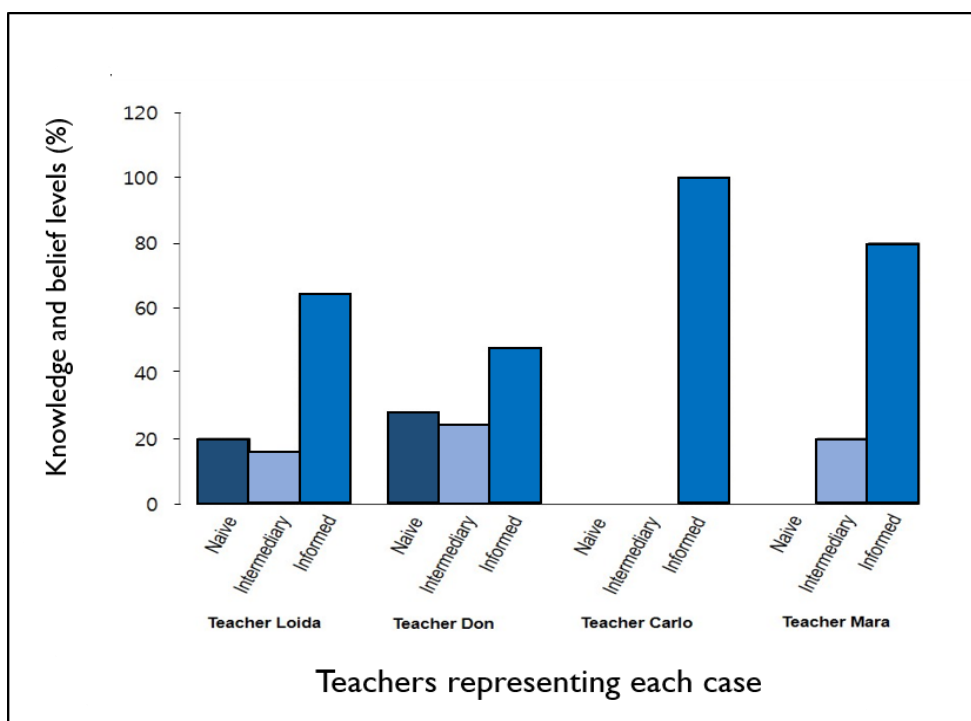


Figure 2. Percentage distribution of the teachers' overall categorized responses for their levels of knowledge and beliefs on the nature of teaching and learning.

In terms of her knowledge and beliefs on classroom argumentation, she was dominantly knowledgeable and possessed informed views (Figure 3). However, it can be observed in Table 12 that though she possessed informed views on the role of argumentation and knowledgeable enough on the dialogic aspects of argumentation, she was not that confident on the abilities of her students and on the nature of the argumentative process. But these views were not noted during the interview when she acknowledged the role of argumentation on students' learning (*"I believe that teaching through argumentation in biology is one of the best methods since students are asked to express their opinions"*) and did not manifest in her enactment of dialogic scaffolding. Moreover, she acknowledged the development of students' argumentative skills to be equally important with learning science content as they were able to practice their critical thinking skills when they were exposed to the direct application of the science concepts to their daily lives through classroom argumentation. Thus, her practice of classroom argumentation was aligned to her constructivist view of teaching when she said,

*“What is the use of the content if the students are not able to apply those in their daily lives? For example, in my case, I didn’t even recognize why I am studying the Mendel’s law in high school. I just knew it in college. See, because we are not exposed to issues that time. So, for me, it is better to expose students with issues aligned to the content.”*



*Figure 3.* Percentage distribution of the teachers’ overall categorized responses for their levels of knowledge and beliefs on the nature and advantages of classroom argumentation.

Teacher Loida’s statements above indicated that she was knowledgeable enough about the dialogic processes of classroom argumentation. Much as she had little beliefs on her students’ capabilities to engage in classroom discussions, her role as a classroom facilitator supported her desire and instructional strategies in implementing classroom argumentation. As a classroom facilitator, she said that, *“I really believe that students should initiate their own learning. We should only serve as facilitators. That’s why what I do is to just open the topic.”* To encourage participation, she usually asked the students to read about socioscientific issues and

prompted her students with critical questions in preparation for classroom discussions. In the following statements, she mentioned about the Dengvaxia vaccine issue which became controversial in the Philippines during the data collection period of this study. She took advantage of the news articles related to this and used them as data sources to implement classroom argumentation.

*“I even ask them to read news related to the content. For example, the issue on the Dengvaxia vaccine which is very controversial now. So they can relate this issue to the ethical considerations in doing science that we discussed before.”*

Table 12. *Level of Teachers’ Knowledge and Beliefs on the Nature of Teaching and Learning and on the Nature and Advantages of Classroom Argumentation*

<b>Knowledge and belief components</b>	<b>SSI-based implementing teachers</b>		<b>Content-based implementing teachers</b>	
	<b>Teacher Loida</b>	<b>Teacher Carlo</b>	<b>Teacher Don</b>	<b>Teacher Mara</b>
<b><i>Nature of teaching and learning</i></b>				
Management	Constructivist	Highly Constructivist	Transitional	Constructivist
Teaching	Highly Constructivist	Highly Constructivist	Transitional	Highly Constructivist
Parent	Transitional	Constructivist	Transitional	Constructivist
<b><i>Classroom argumentation</i></b>				
Role of argumentation	Highly Informed	Highly Informed	Highly Informed	Highly Informed
Dialogic process	Informed	Highly Informed	Intermediary	Informed
Student abilities	Intermediary	Highly Informed	Intermediary	Informed
Nature of argumentation	Intermediary	Highly Informed	Intermediary	Highly Informed

Teacher Loida’s constructivist views on teaching and learning and mostly informed views on classroom argumentation (Figures 2 and 3) were manifested in her dialogic scaffolding practices (Figure 4; Table 12). In this study, the teachers’ dialogic prompts were categorized into conceptual, analytical, and reflective. Based on Figure 4, Teacher Loida’s dialogic scaffolding prompts were almost evenly distributed across conceptual, analytical, and reflective dialogues that sustained the

atmosphere for classroom argumentation. It can be noted in Table 13 that most of her dialogic prompts fall under the reflective type specifically on probing further (24.1%) type of dialogues. This was followed by the analytical type of dialogues particularly on presenting argumentative prompts (21.0%). Results showed that Teacher Loida’s appropriation of her students’ responses was evident as she tried to acknowledge most their responses during their participation in the classroom discussion and expression of their argumentative agencies.

Table 13. *Percentage Distribution of the Categorized Teachers' Dialogues in each Type of Dialogic Prompt*

Types of dialogic prompts	Dialogic components	Occurrence in class (%)			
		SSI-based implementing teachers		Content-based implementing teachers	
		Teacher Loida	Teacher Carlo	Teacher Don	Teacher Mara
Conceptual	• Orienting to hint	19.4	9.0	21.1	11.0
	• Exploring prerequisite knowledge	12.9	11.9	19.3	22.0
Analytical	• Generating ideas and explanations	12.9	18.0	13.8	14.6
	• Presenting argumentative prompts	21.0	21.0	9.1	23.1
Reflective	• Probing further	24.1	26.9	13.8	22.0
	• Enabling reflective thinking	9.7	13.4	22.9	7.3

Much as she mentioned some barriers such as large classes and time constraints which may discourage the implementation of classroom argumentation (*“large classes that we have here in the Philippines...and hmm...lack of time”*), being an experienced teacher made her gain familiarity with the diversity of students’ characteristics and what assistance can be provided to them (*“give them*

[students] *questions that support or counter-argue previous student's opinions*"). She believed that this strategy *"gives the students the idea to speak up."*

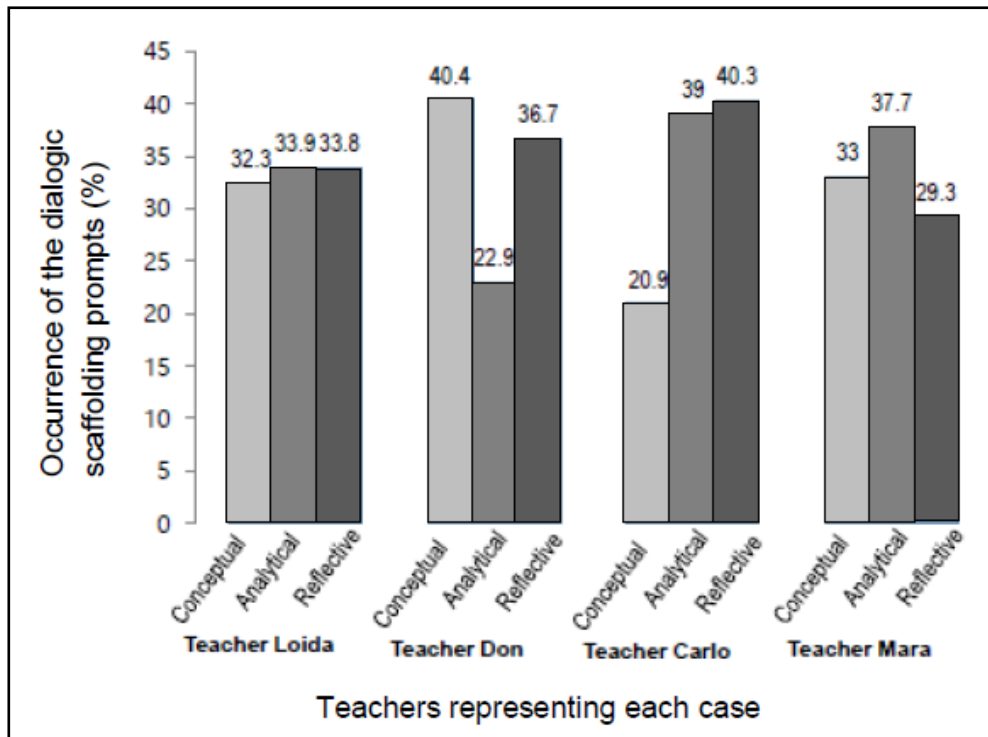


Figure 4. Overall percentage distribution of the types of teachers' dialogic scaffolding prompts.

According to her, she usually started the discussion with an overview of the topic *"so that students will have a background knowledge on the content related to the scientific issues."* Moreover, she mentioned that *"giving them 'how' and 'why' questions will prompt them (students) to think deeper.* With these strategies, she did not sacrifice the value of content knowledge when she said, *"it is really important to introduce content so that they know the concept."*

Teacher Loida's knowledge and views on the nature of teaching and learning and on argumentation was used for her appropriation of her students' responses on the contingency phases of her classes. Based on her classroom dynamics, she usually prepared the students for discussion by providing them with

reading tasks as her way of giving hints to the students about the topic of the day. Moreover, she also linked the current topic to previous topics so that students were able to recognize the interrelatedness of their science lessons and her way to minimize fragmented learning. In the contingency phase, she used two methods on how to appropriate her students' responses: 1) using prior knowledge to build abstract concepts from simple ones; and 2) providing scenarios that may be experienced by the students.

**Teacher Carlo.** Teacher Carlo was also a Junior Faculty member in his school with eight years of teaching experiences and was already exposed to more than 10 trainings on inquiry-based teaching and argumentation as he specified in the preliminary selection of participants. He holds a bachelor's degree in Biology and two Master's Degrees: Master in Education major in Environmental Science and Master in Bioethics (Table 1). At the time of the study, he was the head of the Biology Teaching Group at the Philippine Science High School-Main Campus which is in Quezon City in Metro Manila. According to him, during the time of the study, he just resumed to teaching after graduation from his Master in Bioethics degree from an Australian University. He was then assigned to teach Bioethics as a Biology Elective Class for Grade 10 students to which he was allowed to draft his own teaching sequence based on his academic exposure to the field. As a head in the Biology Teaching Group, he regularly observed classes of other biology teachers and did some post-instructional meetings for them after their observations. He mentioned that he also encouraged other teachers to implement argumentation as it is an effective instructional strategy in science.

Based on the survey, he was the most constructivist (Table 12; Figure 3) among the four teachers and according to him, this was mostly influenced by his academic exposures especially in bioethics backed up with a solid foundation of biology content and his knowledge on pedagogy. He also firmly believed that because his students were inclined to the science field, "*they should be exposed on*

*how to exercise their decision-making since they [must] possess the innate sense of self-awareness towards ethical issues.*” He also emphasized that he was not an authoritarian which were observed from his students who usually had freedom in terms of their seating arrangements. However, he made “*sure that they also pay attention*” to lectures and participate in all classroom activities to maximize learning. Since he also structured the class for argumentation, he did not follow a strict curriculum; rather, he utilized what the students brought to class related to their target socioscientific issues. At the time of observation, it was noticed that his students were almost familiar with the dynamics of argumentation and this, according to him, was a product of their accumulated skills from the start of the school year when he subjected them to classroom argumentation.

Teacher Carlo’s highly constructivist views were also manifested during the interview when he said that argumentation “*deepens students’ content understanding* as they are “*encouraged to communicate their opinions.*” Therefore, he emphasized the importance of developing students’ content knowledge along with doing argumentation because according to him, “*it is where students derive their claims.*” Most of the time, he acknowledged the role of his argumentative prompts for students’ advanced reading tasks which served as guides “*in order for them to obtain arguable statements or [to formulate] their claims so that other students are able to counter argue or refute.*” According to him, it was his way of motivating his students by utilizing their various opinions “*in a sense that when various claims are laid down, there are more areas for counterargument.*” As a facilitator, he said, “*I express my opinions too... especially when it is so hard to obtain other students’ opinions. In this way, other students are able to frame their thinking because of my opinions.*”

With a strong foundation of knowledge and beliefs on argumentation, he expressed his optimistic view for classroom argumentation as a “*very promising teaching strategy... if one only recognizes the importance of critical thinking.*”



Moreover, he believed that through argumentation, students are empowered to *“think and express themselves according to their capacities.”* With these beliefs on classroom argumentation and students’ capacities, he usually encouraged his co-teachers to implement argumentation so that students will not *“know so much with the ‘what’ and ‘which’ of their content”* but more so of how to evaluate issues related to these. He further emphasized, *“a class is really boring if you only teach information. Students tend to just stare at you while you are doing the talking.”*

Teacher Carlo’s strong beliefs on constructivism and highly informed knowledge and beliefs on classroom argumentation (Figures 2 and 3; Table 12) were observed in most of his classes with dialogic prompts mostly focused on the analytical and reflective dialogues. These were particularly observed in the generating ideas and explanations (17.9%), presenting argumentative prompts (20.9%), and probing further (28.9%) dialogic prompts after merging the results of the analysis of the classroom transcripts and observation guides (TDSAOC). This supported his claim that *“argumentation is the only teaching strategy”* that he implemented in his Biology Elective class. Moreover, he claimed that all students can engage in classroom argumentation and that *“it’s only a matter of how the teacher regulates the discussion in class”* and that *“personal decision to teach argumentation matters a lot.”*

Holding on to his constructivist view, Teacher Carlo’s dialogic scaffolding in the contingency phase was characterized by establishing a culture of negotiation as he provided neutral points and assisted his students of converging disparate ideas for collective consensus. It was observed that most of the students in his class possessed the sufficient cognitive abilities to integrate their lesson topics across different fields and were able to express elaborated responses as they provided evidences for their claims. Despite of this, Teacher Carlo remained neutral which created a permissive atmosphere of cooperation as they minimized the competition of ideas; thus, urging mutual respect among his students. Therefore, they were able

to establish a healthy argumentative discussion characterized by cooperative search for coordinated and collaborative consensus.

To incorporate the principles of the sociocultural theory, the zone of proximal development, and scaffolding, Teacher Carlo's short but open-ended dialogic prompts served as his contingent assessment for the depth of his students' knowledge about their topic. Moreover, as he slowly built the capacities of his students towards the fading phases, he continued to elicit more responses by putting emphasis on the relevant points which prompted them to respond and find the place of their ideas in their discursive interactions. Through his explicit decision to implement argumentation, it followed that his dialogic scaffolding practices established their classroom into a social and verbal activity which facilitated the development of students' reasoning skills during their expressions of argumentative agency (Sampson & Clark, 2008; Osborne, 2010). As he contingently and dialogically prompted the students to present their claims with evidences, they were able to identify the strengths and weaknesses of their insights which were later used to converge and achieve consensus.

**Content-based classes.** The other two teachers observed in this study were also implementing two different types of curriculum, each from DepEd and DOST. Unlike the first two teachers presented, they taught the Regular Biology classes, one from the DepEd curriculum and the other from the DOST curriculum. These teachers also differed in their levels of knowledge and belief systems which influenced how they framed their instructional approaches for the Regular Biology classes which eventually influenced their decisions to implement and dialogically scaffold the students' expressions of argumentation agency in their argumentative discussions.

**Teacher Don.** Teacher Don was a Junior Faculty member in his school who obtained a bachelor's degree in Education major in Physics. In this study, his classroom represented the general public high school (GPHS) curriculum under the

new K to 12 curriculum in the Philippines (Table 1). According to him, he was exposed to more or less five training programs and/or seminar workshops on inquiry-based teaching which included argumentation, and these were primarily from the in-service training programs administered by his school as mandated by the Department of Education. He was in the same school as Teacher Loida but he belonged to the GPHS department which followed the general science curriculum implemented in majority of the public high schools in the Philippines.

Based on the overall percentage distribution of teachers' responses on the survey, Teacher Don held transitional beliefs about the nature of teaching and learning (Table 12). This was mostly observed in both his responses on the items corresponding to instructional strategies (25.9%) and classroom management component (18.5%). During the interview, he also mentioned that he managed students' laboratory activities by "*orienting them in what they are going to do in order "to avoid them asking so many questions when they are already doing their activities."* In terms of his classroom instructions, he mentioned that he still considered himself as *a traditional* teacher, but he acknowledged the effectiveness of a constructivist teaching especially when he observed the classes of Teacher Loida. Thus, he was optimistic on his aspiration to become a constructivist teacher when he stated,

*"Maybe in the coming years, I will learn how to teach biology in that way. But I am trying. Sometimes, in the higher sections, students are good in discussions, so I take advantage of it. I ask them to discuss by themselves and present their results in class. And I also allow others to comment so that they will know how to defend their answers."*

His desire to slowly become a facilitator of learning in class was evident in his method of assessing his students. He said that he involved them (students) in assessing themselves especially for their group activities by allowing them to "*rate themselves and their groupmates based on how they contributed in their*

*activities.*” Furthermore, he considered students’ ratings in the final computation of grades in some of their outputs “*I allow them to compute the average of that (students’ scores) and together with mine, that’s their final grade.*” In terms of his dealings with the parents of his students, his responses were all aligned to the constructivist views and these were also supported by the results of his interview when he said that he is always open for clarifications and involved the parents in setting the rules particularly in his advisory class.

Results of the analysis showed that Teacher Don was the least constructivist among the four teacher-participants. However, his beliefs on the effectiveness of classroom argumentation and his desire to become a full practitioner of constructivist teaching were positive indicators for the improvement of his approaches to teaching and learning. In this study, his dialogic scaffolding for his students’ expressions of argumentative agency served as evidences for his desires to gradually become a believer and an agent of constructivism. Much as his dialogic prompts were not as challenging as that of Teacher Carlo, he was able to generate student-centered questions which made his students his complimentary experts in the knowledge construction (Jimenez-Aleixandre, Rodríguez, & Duschl, 2000) rather than just repeaters of the factual knowledge to confirm textbook explanations (van Zee & Minstrell, 1997). As compared to the other teachers, students’ responses in Teacher Don’s classes were short and unelaborated. However, he was able formulate and provide contingent dialogic prompts through his conceptual-reflective questions and utilize the few critical points raised by some students to extend their discussions instead of providing evaluative prompts.

In terms of his knowledge and beliefs on argumentation, he held transitional knowledge and beliefs on classroom argumentation (Figure 3). Results of the interview slightly contradicted his transitional views based on his responses on the survey instrument regarding the role of classroom argumentation in science learning. Analysis showed that he can be regarded to possess naïve views on the

nature of classroom argumentation when he said that it was more suitable in biology classes because of the ethical issues related to biology topics (*“it is recommended in Biology because of the ethical issues and not particularly in physics because of the “lesser socioscientific issues”*). One factor that hindered him from implementing classroom argumentation was his limited knowledge (*“My only problem is I am not a biology major so I cannot do it. I will have to study content maybe so that I can implement it in class”*). Much as it was one of the recommended teaching strategies in the curriculum, he said, *“I don’t know how to implement it.”* Moreover because of *“lack of time and a lot of cancellations of classes during the school year because of natural disasters,”* he usually focused on teaching pure science content. However, with his desire to become a constructivist teacher, he said that he sometimes observed the biology classes of Teacher Loida where he observed that she used debate as one of her strategies to implement classroom argumentation.

Teacher Don’s transitional level of constructivism and intermediary levels of knowledge and beliefs on classroom argumentation (Figures 2 and 3; Table 12) influenced his dialogic scaffolding practices to be mostly focused on conceptual dialogues. However, the presence of his reflective dialogues that supplemented the conceptual ones in his implementation of classroom argumentation extended the students’ participation and increased their expressions of argumentative agency. According to him, his reflective dialogic prompts were particularly focused on *“why and how questions so that they (students) can give explanations. These are questions on practical knowledge like how they apply their biology knowledge in their daily lives.”* Moreover, based on the interview, he stated that most of his analytical prompts were focused on encouraging students to *“defend their opinions”* using their prior scientific knowledge especially on how they *“make connections of the biology concepts to daily lives.”*

Based on the summary of results of the observation checklist (TDSAOC), and the iterative analysis of the classroom transcripts, Teacher Don's dialogic scaffolding prompts were dominantly conceptual in nature (Table 13; Figure 4) consisting of giving hints to students (21.1%) and exploring their prerequisite knowledge (19.3%). This was followed by reflective dialogues particularly on enabling students to exercise reflective thinking (22.9%). According to him, his reflective dialogic prompts were particularly focused on "*why and how questions so that they (students) can give explanations*" which are focused on practical knowledge prompting his students to express their insights which sustained and extended their discussions of conceptual and canonical knowledge.

Teacher Don had transitional and intermediary levels of knowledge and beliefs on the nature of teaching and learning and on the nature of classroom argumentation. However, with his desire to implement inquiry-based teaching in his Regular Biology class, he was able to implement classroom argumentation and dialogically scaffold his students' expressions of argumentative agency. This desire resulted from his recognition on the advantages of classroom argumentation based on his participation to various professional development efforts augmented by his observations from an experienced teacher (Teacher Loida). Combining these, he was able to dialogically scaffold the students' expressions of argumentative agency through conceptual-reflective strategies of conceptual and canonical concepts which were extended using analytical dialogic prompts.

In the contingency phases, Teacher Don's dialogic scaffolding practices were dominantly conceptual and reflective dialogic inquiry. These were done through questioning related to conceptual-canonical knowledge and reflective inquiry as he tried to engage his students to relate their lessons to previous and practical knowledge. Unlike the questioning in a traditional classroom, the transitional views of Teacher Don towards constructivism influenced his implementation of questioning the factual and canonical knowledge to elicit what

his students were thinking, help them to collaboratively and dialogically construct their knowledge, and elaborate and restructure their ideas based on the series of peer-to-peer interactions. Moreover, as he claimed to gradually develop his constructivist beliefs, he was able to make his questions flexible enough to accommodate students' responses and make explicit in himself to minimize evaluative prompts thereby throwing back the responsibility to the students to think and reflect on their prior utterances. These series of questioning factual and canonical knowledge built up the students' expressions of argumentative agency to the fading phases as they were prompted towards independent discussions from his dialogic prompts.

Progressing from the conceptual factual-canonical questioning, Teacher Don's students were prompted to apply the concepts of their current lesson to their daily lives or to connect these to their prior knowledge through his initiative for reflective inquiry. As he transitions from a traditional to constructivist teacher, he recognized that alongside with the development of students' conceptual knowledge, their epistemic and reflective inquiry must also have a place in their knowledge construction. This dialogic scaffolding strategy aligns with promoting epistemic understanding through dialogic discourse (Bendixen, 2016).

It is important to emphasize that his reflective dialogic prompts were open-ended so that various students' ideas were accommodated making them do most of the talking and building up their ideas. This acknowledges the theoretical framework of this study from Vygotsky's sociocultural theory which emphasizes the importance of language in human development and learning. Moreover, applying the principles of ZPD established his role of dialogic scaffolding towards student-centered and argumentative discussions. Reinforced by the social constructivist principles, dialogic instruction, as seen from Teacher Don's class was a combination of authentic questioning and restructuring of opportunities for students to develop their critical thinking process.

**Teacher Mara.** Just like Teacher Don and Teacher Carlo, Teacher Mara can also be considered a junior faculty in the same school with Teacher Carlo with 11 years of teaching experiences and a significant number of exposures to professional development in inquiry-based teaching which included classroom argumentation. She holds a bachelor's degree in Biology Education and a master's degree in Education Major in Biology (Table 1). According to her, she has been teaching genetics classes from the start of her teaching practice to regular Grade 10 students but with the implementation of the K to curriculum, her teaching loads included other branches of biology in other grade levels.

Analyses of survey data revealed that she was constructivist in her knowledge and belief systems and according to her, she usually involved her students in negotiating whatever decisions they have in class. According to her, when the students *“were involved in setting of the rules, they will be responsible enough to obey those rules...”* and she can always *“remind them that they set their own rules, so they have to follow them.”* Moreover, students were also involved in setting dates of their mini-exams and the deadlines for project submission but not usually on the lesson sequence. She also mentioned that her students did not have regular seating arrangements and regular group members for their short classroom activities but in terms of group compositions for laboratory works, she usually had permanent grouping for an extended period (one quarter [3-4 months] of the school year) and involved the students for necessary changes whenever they requested for regrouping together with her assessment of group performances.

She admitted being a bit strict but preferred to be a facilitator during class discussions because she believed that it is *“better and it is more effective when students are involved in their own learning.”* As such, she believed in the capacity of her students to initiate their own learning by *“tapping their skills and providing them opportunities.”* In terms of assessments, she used various methods of assessing student learning outcomes and allowed collaboration especially for



performance assessments so that they “*can ask questions from each other before asking it (to her so they) all save time.*” Parents of her students were usually involved in the learning process when she assigned tasks which required the students to “*interview their parents or professionals*” so that they are able to obtain primary data for classroom discussions.

She implemented argumentation by assigning the students some reading tasks related to their lessons. Reading topics usually included “*controversial issues that can be discussed in class*” and through these, students formulated their arguments based on the information from their readings and “*their knowledge of content.*” When asked about the advantages of implementing argumentation, she said that it helped the students to express themselves as they become more responsible for their learning (“*It is helpful coz the students think deeper and they are able to express themselves... students become more responsible on their learning*”). Interview transcripts also showed that she was *knowledgeable* enough on the nature of classroom argumentation when she said that “*students have to present their claims and back it up with their evidences.*” She also put high regard on her students’ abilities by “*giving them opportunities to express their opinions.*” She believed that through argumentation, classroom discussion became active and the factual type of learning were minimized. She exclaimed,

*“I just came to realize that I can have active participation in class if you do argumentation and the class will not be boring. If you just teach the content, they will just answer the “what” and the “which” so it becomes boring... very factual.”*

Even though her instructional practices were mostly content-based, her constructivist views were evident in her approach to argumentation teaching. She specifically implemented classroom argumentation because she recognized the importance of student interactions and through her dialogic scaffolding, their argumentative discussions revolved around reorganization and integration of

students' prior knowledge for use in articulating the current information of their new content knowledge. Her dialogic scaffolding aligns with previous study which claims positive results when students are provided with the opportunities to be involved in accomplishing the objectives of their lesson in an interactive environment where they jointly clarified and resolved their differences in understanding of science content (Levitt, 2001). Her response to the interview about changing her role as a sole transmitter of knowledge to a facilitator of learning and her instructional practices were aligned to the current recommendations of reform-based instructions. Moreover, despite content-focused topics, she was able to show flexibility by establishing meaningful inquiry opportunities as she gave her students the initiative to either accommodate or reorganize their knowledge frameworks.

In the content-based classroom environment of Teacher Mara, providing opportunities for elaborated discussions was a challenging task. However, her constructivist views, knowledgeable level, and informed views on classroom argumentation affected her attempts to engage her students in a discursive exchange of insights in their knowledge construction. Her dialogic prompts were mostly framed to elicit her students' responses with a goal for a collective consensus in their construction and reconstruction of prior and existing knowledge. Moreover, it was observed that despite the dominance of constructive argumentative agencies of her students, she prevented herself from attempts to provide immediate evaluative prompts. Also, in some instances when students directed their clarification questions to her, she was responsive enough to recast and recapitulate these clarification questions and gave other students the opportunities to express personal insights related to these questions thus, increasing expressions of their argumentative agency.

As her topics is mostly content-based (Table 3), the combined analysis of the classroom transcripts and the observation guides revealed that Teacher Mara's

dialogues were almost *equally* distributed across conceptual, analytical, and reflective dialogic prompts. These data supported her claim about the equal importance of content knowledge and decision-making skills of the students [*“They (students) should be equipped with enough knowledge of the content because they will have to do decision making in the future”*].

Teacher Mara’s framing of instructional approach to her Regular Biology class was also affected by her constructivist and informed levels of knowledge and beliefs on the nature of teaching and learning and on the nature and advantages of classroom argumentation. Because of this, she was able to implement and eventually dialogically scaffold the oral classroom argumentation through her flexible affirmations of students’ ideas for collective consensus by providing reinforcement for mutually contingent dialogic exchange and revoicing to increase students’ backing and to enhance their discursive identity.

Teacher Mara’s dialogic scaffolding practices centered on flexible affirmations of her students’ conceptual argumentative responses by providing them enough reinforcements to their dialogic inquiry and revoicing their responses to acknowledge and enhance their discursive inquiry (Table 9). Analysis showed that reinforcement, as applied to the dialogic scaffolding of Teacher Mara, is a method of dialogic scaffolding characterized by attending positively to students’ desire to participate in the argumentative discussions by highlighting the critical and important points of what and how their ideas contributed to the quality of their discussion. Her students’ responses became a stimulus to her to formulate more contingent dialogues that elicited more participation and expressions of their argumentative agency. Thus, their dialogic interactions served as a mutual contingent to each other’s engagement in classroom argumentation (e. g. contingent to teacher’s dialogic prompts and contingent to students’ expression of argumentative agencies).

The other dialogic scaffolding practice that Teacher Mara implemented was constructively revoicing or recapping her students' responses and this was somewhat related to Teacher Loida's appropriation strategies. It was her way to acknowledge her students' argumentative roles by systemically using their interaction exchanges by paraphrasing their utterances highlighting the important points that were meaningful to their current discussions. It therefore signifies that her constructivist beliefs and informed knowledge and beliefs on classroom argumentation influenced her to become responsive in reshaping the students' contributions using her dialogic scaffolding prompts. Moreover, constructive revoicing became a positive feedback which enabled the students for fuller and more elaborated responses.

Through these dialogic scaffolding practices, she was able to implement classroom argumentation where her students developed the responsibility to accomplish the objectives of their lesson. For instance, it can be observed from the sample transcripts on their lesson on pedigree analysis that Teacher Mara leveraged the classroom talk not to evaluate students' responses but instead, she utilized their statements to expand and clarify their thinking using scientific terminologies as they processed their individual knowledge to support each other's articulation of the scientific facts (Kawalkar & Vijapurkar, 2013; Mercer, Wegerif, & Dawes, 1999). This simply means that given enough guidance, students are able to develop independent thinking which is shaped by their social experiences with their peers (Rogoff & Toma, 1997). Instead of the dyadic or triadic interaction, students became argumentative agents to lead the inquiry process, critique, support, and evaluate one another's lines of thought. Dialogue in this case was recognized as a collaborative enquiry process wherein each student's contributions were valued to possess unique perspectives with thoughtful consideration of finding solutions to existing problems (Bakhtin, 1982; Higham, 2016; Kazepides, 2012).

### **5.3. Students' expressions of argumentative agency in response to teachers' dialogic scaffolding practices and strategies**

In this study, results showed that the students' expressions of argumentative agency were dependent on the teachers' dialogic scaffolding in both the contingency and fading phases of their classroom discussion. With the various dialogic scaffolding practices of their teachers, their responses showed that they were receptive enough to express their argumentative agency and were cooperative to participate in their argumentative discussions. Literature has established the social processes associated with science education and as such, in science classrooms, students are required of the ability to engage in communicating about science as they generate and assess scientific explanations (Driver, Osborne, & Newton, 2000; Duschl, Schweingruber, & Shouse, 2007).

In this study, with the initiative of the teachers to move away from the traditional IRE pattern of classroom interaction, students' science content and process skills were simultaneously developed during their participation to their oral argumentative interactions. Through teachers' dialogic scaffolding, discussions put them at the center of the learning process especially in the fading phases when they were provided the autonomy to express their argumentative agency to either constructively or critically express their arguments, counterarguments, or rebuttals from the dialogic prompts of both their teacher and their peers. In the contingency phases, their science content knowledge were primarily developed with the majority of conceptual dialogic prompts their teacher provided in order to establish the significant scientific concepts associated with each of their topics. Moreover, these were augmented using the analytical and reflective dialogic prompts when they were asked to connect their current lessons to their previous scientific knowledge and to identify social applications of their science topics to their daily lives.

In their dialogic exchanges, their scientific communication skills were also developed as they claimed accountable to their arguments, counterarguments, and rebuttals, and as such, they were readily responsive to defend their claims when challenged by their peers. This process deepened the quality of their discussions especially in the SSI-based classes when they tried to identify the varied applications of their science concepts to other fields. As new concepts were added into the discussion scenario, other students who shared the same ideas expressed their constructive argumentative agency such as to support or to provide further reasons that strengthened the validity of the claims. On the other hand, at times when new concepts were intriguing for some students, they were able express their critic argumentative agency such as to challenge the claims, evaluate the validity and quality of the arguments by asking for evidences, and clarify the relationships of the science concepts to those previously stated by others. Thus, as students expressed their argumentative agency, their exercise of communication skills facilitated the development of their critical thinking skills which can be observed from their arguments, counterarguments, and rebuttals.

In the content-based classes, more than the science concepts that they were concerned during the discussions, the dialogic prompts of their teachers went beyond 'what' were to be known scientifically to 'why' and 'how' they should be known through their analytical and reflective dialogues which elicited their argumentative responses. In their conceptual learning process, students were prompted to establish the interrelationships of their science content by identifying those previously acquired concepts associated with the current ones. Thus, through this, their science learning process cannot be associated to the conventional science learning which concerned only and purely on the products which were usually assessed through examinations. In this study, the skills they acquired were treated as equally important with the development of their science content knowledge while they were enabled to practice the activities of science through argumentation.

In this study, students' responses to their teachers' dialogic scaffolding as expressions of their argumentative agency resulted to various patterns and trajectories of utterances as shown in the argumentative maps. Results of the analysis suggested that the teachers' framing of their instructional approaches guided their dialogic scaffolding and this played a crucial role in establishing the peer-to-peer interactions in their argumentative discussions. This was observed in the types of argumentative maps that were constructed. For instance, the simple argumentative maps were mostly found in the content-based classes wherein students responded to their teachers using conceptual information. Moreover, the interrelated factual-canonical ideas limited them in their expressions of their argumentative agency to the constructive type such as support or reason out.

It can therefore be said that due to the conceptual dialogic prompts, students' ideas tend to converge as they support each other such as those in the simple linear argumentative maps. There were also instances when the conceptual dialogic prompts yielded to the combination of the constructive and critic types of argumentative agencies. In some cases, since the topics for discussion were conceptual, there were few diverging ideas which limited the counterargumentative statements. Thus, in the simple linear argumentative maps, few students were engaged in the discussions expressing primarily the constructive type of argumentative agencies. These were also found in the SSI-based class when the teachers' dialogic scaffolding prompts tried to build up the scientific concepts related to the underlying issues for discussion. These led to the simple constructive argumentative maps. This type of simple argumentative map differed from the simple linear in the number of students participating in the discussion and sometimes, the contingent dialogue of the teachers was found at the middle of their dialogic exchanges as they cued the students to express more of their constructive ideas.

### ***5.3.1. Theme 1: Neutral and immediate application of scientific knowledge in their dialogic responses in the contingency phase***

In the contingency phases of the SSI-based classes of this study, students expressed their argumentative agencies in response to their teachers' dialogic scaffolding practices by sharing their neutral and immediate knowledge to apply their scientific knowledge during their expressions of argumentative agency (Table 10). The students in the two classes, however slightly differed as they responded to their teachers' dialogic scaffolding practices. In Teacher Loida's class, students expressed their argumentative agency and were responsive to her dialogic scaffolding practices by sharing their personal experiences and prior knowledge which served as dialogic prompts to everyone.

Research found out that students have the notion that science learning is a memorization of facts that needs to be evaluated through examinations (Tsai, 2004). However, in an inquiry-based learning, these conceptions are eradicated by engaging the students in peer-to-peer discussions through classroom argumentation. It follows therefore that the consideration of the students' ideas should be an important factor for teachers during their classroom implementation. Their consideration should not only be focused on the diversity of the students' prior knowledge and skills but also on the type of learning environment they are to be subjected to. In this study, the teachers framed their science classes towards classroom argumentation which were aligned to the advocacies of transformative learning. With the teachers' recognition of their students' capacity to engage in fully-argumentative classroom scenarios, they were able to successfully implement classroom argumentation through their various dialogic scaffolding practices that were observed in the contingency and fading phases.

From the sociocultural perspective, students were treated as individuals with unique experiences and prior knowledge that can be brought into the classroom. As such, as they engage in the various learning strategies in the



classroom and over time and as they can acquire the norms and skills required of them by the instructional approaches of their teachers, their knowledge and skills developed using the combination of the new conceptual knowledge and the refinement of old conceptual knowledge.

*Sharing of personal experiences and prior knowledge which served as contingent dialogic prompts to both the teacher and students.* In the SSI-based classes of this study, students' responses in the contingency phases were characterized by their neutral and immediate application of scientific knowledge to the dialogic scaffolding practices of their teachers. In the case of the STE-Biology Elective class, students' responses to Teacher Loida' appropriation strategies was sharing of their unique experiences as they developed abstract scientific knowledge from simple ones. Students were engaged in the discussions by Teacher Loida's elicitation of their ideas and perspectives using reflective dialogic prompts. Thus, students were enabled to make sense on the nature of their learning process and were gradually accustomed to the dialogic nature of their discussions.

It can be noticed in their responses that when Teacher Loida prompted them with new concepts, examples were usually observed in their responses which brought about the development of knowledge from simple to abstract concepts. For instance in Transcript 1 during their discussion on 'Cloning,' Grace' initial dialogue, "making a copy of yourself," indicated that she understood the concept but in a 'layman's' term. Through Teacher Loida's appropriation strategy (Line 7 to 8), she was able to express more of what she knows, thus coming up with a more scientific response when she gave a follow-up response using "Dolly, the sheep" to express her knowledge on cloning.

In this contingency phase, Teacher Loida was aware of the complexity of their topic. However, she continued to elicit students' knowledge and progressed the classroom discussions towards the target scientific knowledge by continuously providing hints and increasing the responsibility of the students to form the abstract

concepts. In their dialogic interactions from Line 15 to 20 in Transcript 1, it can be observed that her conceptual dialogues were mostly cued eliciting through which the students were responsive enough to share their ideas. In this chain of utterances, Gil was responsive enough to share his research ideas when he responded to Teacher Loida's prompt to read what he has noted in the reading assignments. It was in this 'reading response' when Gil was able to bring out the concepts of 'reproductive and molecular cloning.' Through Teacher Loida's appropriation strategies, the concept of cloning which started from associating it to "Xerox" copying in Line 7 (Teacher Loida: "*Do you mean like a Xerox copy of yourself?*") was developed into the "reproductive and molecular cloning" from Gil's readings.

As the discussion continued in Transcript 1, Teacher Loida continued to appropriate the prior knowledge and experiences of the students. From Lines 25 to 29, Teacher Loida was just providing background information to increase the background knowledge of her students. This was also her way to increase the depth of their discussions when she associated reflective and analytical statements from the background knowledge that she provided to which the students were also positive in their uttered responses. In these lines of dialogues, Teacher Loida was asking about the DNA of the newly-cloned lamb. As she recognized the complexity of the question, she gave them a simple summary of the reproductive cloning technique and even defined the term 'surrogate' in Line 26. Because of this, Chris was able to formulate his claim. He was also responsive enough to the contingent dialogic prompt so that after organizing his ideas after few seconds, he was able to give justification for his claim. Teacher Loida was aware of his faulty answer. However, she minimized evaluative prompts that would immediately contradict and give the answer to Chris' answer. She minimized expression of deviant answer that would signal the class that Chris' answer was not right. Instead, since she was concerned on the students' explanations to their claims. She encouraged others to express their ideas through her dialogic prompts which

elicited the ideas of Karen in Lines 34 and 36 when she expressed a counterargument to the answer of Chris about the closed similarity of the cloned DNA to the donor and not on the surrogate. Karen's answer showed that her responsiveness was a product of her articulation of her prior knowledge on the nature of the DNA and the background of Teacher Loida in Line 25 to 29.

This dialogic interaction on their lesson on cloning commenced with the identification of the students on the direct application of their lesson to their daily lives. Based on Line 58 to 61 in Transcript 1, Teacher Loida provided a scenario particularly addressing it to the female students in class about their decision to undergo reproductive cloning if it happens that they were unable to bear children in the natural way once they will get married. This scenario became controversial and students were reactive and were specifically concerned about the 'normality' of their new-born babies once they undergo such a procedure. However, when they identified a famous celebrity doctor in the Philippines who underwent the procedure, they were able to establish consensus in their discussion. Much as the final decisions were not specified in Transcript 1, during the classroom observation, their familiarity of the success from the celebrity doctor whom they were all aware of established a calm atmosphere which brought back the class into their discussions.

Transcript 2 was a progression of their discussions in Transcript 1. Still on the issue on the 'normality' of the cloned individual, they used 'Scarlet Belo,' the daughter of a famous celebrity doctor to establish their decisions whether they would regard a cloned individual a normal individual or not. It can be noted in their dialogic interaction that Dianne's response was based on a previous dialogic prompt of Teacher Loida about the procedure for cloning individuals (Line 4 to 5). Claiming that as the blastocyst is allowed to be fully developed in a surrogate during cloning, the new life can be considered normal once it reaches full development. Renan even uttered his supportive statement that "*as long as it does*

*not look like alien,*” and comes out as a normal human being, the cloned individual can be considered a normal individual (Line 9). However, he counterargued his own statement after Teacher Loida asked him what he meant by ‘alien.’ In response to the appropriation strategy of Teacher Loida, he expressed his prior knowledge about the normal way of human reproduction but was not able to mention the term for copulation. In the observation, it was noted that at this time, his implied idea about the copulation created laughter among other students who understood the meaning of his statement but Teacher Loida was quick enough to appropriate his ideas by soliciting further decisions to which Dennis responded in support of Renan that normal individuals can only be produced in the process of copulation.

The dialogic interactions of Teacher Loida and her students in the contingency phase align with the principles underlying the rationale of the study. Social constructivists hold the awareness of the knowledge construction and not transmission. In Teacher Loida’ class, the students were able to contribute in their knowledge construction as they expressed their argumentative agency in response to the dialogic scaffolding practices of their teacher. Moreover, they were able to express their cultural beliefs during their construction of reasoned arguments which supported their claims. With Teacher Loida’s recognition of situating their learning process in their zone of proximal development, her dialogic prompts that were directed towards bringing out their personal experiences and prior knowledge to the issues were associated to their lessons. In the process, the classroom atmosphere was not subjected to dilemmas which led to insecurity and unelaborated discussions when tensions arise. Instead, their responses using their personal experiences yielded to a neutral dialogic exchange which preserved the calmness of the learning environment so that their thinking processes were not held up.

In order to understand how the teachers' dialogic scaffolding affected the pattern of discussions in the knowledge construction in this study, few segments of the fading phase in each class were mapped using the responses of the students to their teachers' dialogic scaffolding. In Teacher Loida's class, students' expressions of their argumentative agency and segments of their responses can be shown through argumentative maps. Segments in the dialogic interactions similar to the Transcript 1 and 2 of Teacher Loida's class can be shown using a simple linear argumentative map. It can be observed that in few segments where students were given autonomy to discuss by themselves, the teacher's dialogic scaffolding prompts were able to elicit students' responses with chains of opinions usually constructive in nature. Figure 5 shows a simple linear argumentative map in Teacher Loida's class with students interacting with each other using support as constructive argumentative agencies.

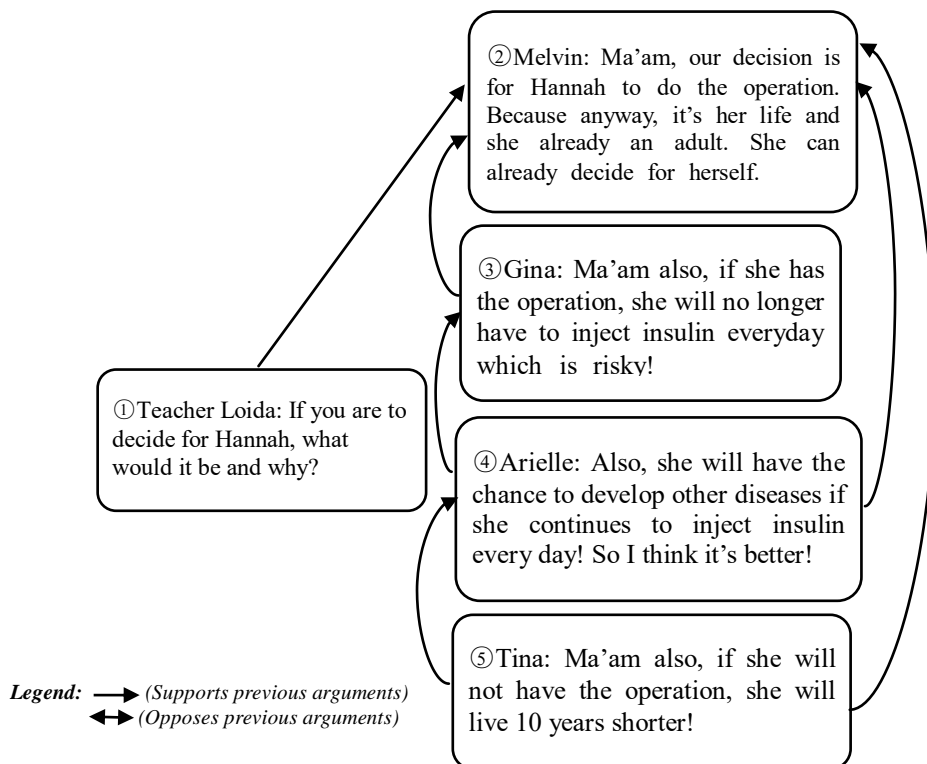


Figure 5. Simple linear argumentative map in the SSI-based class with students' expressions of supportive argumentative agency.

In the argumentative map in Figure 5, the discussion started with Melvin's initial argument supporting the stem cell operation for Hannah to cure her diabetes. This was supported by Gina with a justification that the success of the operation using stem cell therapy will result to Hannah's independence from insulin injection. This was further supported by the justification of Arielle when she said that using stem cell therapy in curing diabetes would minimize the risk of developing related diseases due to regular insulin injections. Melvin's argument was even strengthened with by Tina's supportive statement using evidence from the data and reiterated that Hannah will have 10 years shorter lifespan if she will not undergo stem cell therapy. In this discussion, it can be observed that there was limited number of students participating in the discussion when they are confined to the expression of their constructive argumentative roles. Moreover, as they just support each other, no counterargumentative statements were expressed making the map simple and linear.

Based on the transcripts and on the argumentative maps that was produced in the contingency phase of Teacher Loida's class, as the students responded using neutral statements about their personal statements, these responses were appropriated which created small ideas which served as a foundation for their support of scientific ideas, make links to prior knowledge, and process and reconstruct existing ideas. As these dialogic interaction continued to be observed in the SSI-based classes of Teacher Loida, it can be understood that students gradually acquired the principles of constructivism which was embedded in their learning environment. In the process, they became agents of their learning process and became actively involved in the revisionary procedure of knowledge construction where ideas are refined or replaced with new ones through their dialogic interactions.

*Two-sided responses which further elicit peer-to-peer interactions.*

Teacher Carlo's dialogic scaffolding practices in the contingency phases of their classroom argumentation was enactment of the culture of negotiation. In response, students were able to offer two-sided stances which further elicited peer-to-peer interactions. It can be noted that students in Teacher Carlo's class were opinionated during their expressions of their argumentative agency. This can be attributed to their maturity since they were already in Grade 10 as compared to the Grade 8 students of the other teachers. Thus, it can be inferred that they were already equipped with baseline knowledge and skills acquired from their previous years which can serve as their knowledge capital in the discussions of bioethics issues in their Elective class. As a highly constructivist teacher, Teacher Carlo was aware of these, thus making him adjust his implementation of classroom argumentation to encourage negotiation of ideas in the contingency phases. It can be inferred that this was his way to minimize heated arguments that would impede the progress of interactions from the contingency to the fading phases. Therefore, his dialogic scaffolding prompts converged into the establishment of a sound learning environment where students were free to express their opinions without fear of being halted in the dialogic exchange.

Students' expressions of argumentative agency and their responses to Teacher Carlo's dialogic scaffolding practices can be observed in Transcript 3. As a dialogic prompt, Teacher Carlo initiated the discussion by asking the students about the importance of doing research involving human samples with consideration on the ethical value and the scientific value. To prompt the students with neutral points which would progress into collective negotiations, he established the background information; thus increasing the foundational knowledge for the discussion with his five-lined statements. In response, Carl was quick in answering with neutral stand when he said that with the existence of models, it is important that these should be followed in order to gain the maximum

potential of both the ethical and scientific value of doing a research (Line 6 to 7). To further elicit ideas, Teacher Carlo asked for examples which illustrated the meaning of what Carl has mentioned. Grace responded with 'pain tolerance' as an example and her explanation illustrated two-sided opinions which prompted Teacher Carlo for a recapitulation. Despite the recapitulation of Teacher Carlo, her classmates seemed not convinced with her example and her explanation; thus prompting the series of dialogic exchanges of Carl and Jean (Lines 13 to 19) using the Nazi experiment as another example to illustrate their two-sided responses as expressions of their argumentative agency. In their dialogic exchange, it was noted that Jean kept on counterarguing the claims and justifications of Carl. In order to increase the strength of his claim, Teacher Carlo encouraged Carl to elaborate on the Nazi experiment as an example for the illustration of the ethical and scientific value of an experiment. However, he failed to give further elaborations (Line 22).

As their discussion went on, Teacher Carlo recognized the limits of their articulation processes and because of this, he tried to let the students consider the scenario in the 'Clinical Trial Stage' if this can be an example to illustrate the ethical and scientific value of doing a research. In the responses of Jacob, it was also evident that he responded with double-sided position saying that in clinical trial stages, if the participants were compromised, the ethical value of the research. However, he was not able to elaborate his answer. Gem followed in the interaction by giving the Stanford prison experiment as another possible example to consider when looking at the ethical and scientific value of doing research. As she mentioned that issues associated to the experiment despite their abiding of the standard ethical procedures (Line 27 to 28), Teacher Carlo recapitulated Jacob's statement in Line 26 about the increase or decrease of either the ethical or the scientific value if participants' welfare were compromised. Gem responded and she claimed that the scientific value did not decrease but the ethical value decreases when participants' welfare were sacrificed such as when they were not allowed to



withdraw from the research if they felt that were already abused. Her responses in Line 29 to 31 was indicative of her desire to express two-sided opinions which reconciled the issue of maximizing the ethical and scientific value of research using the Stanford experiment as an example. She then finished with her objective to resolve this by mentioning about the strict compliance of researchers on the universal standards to obtain a maximum benefit of a doing research involving human samples by ensuring both its ethical and scientific values.

This was also observed during their discussion on the issue on ‘quarantine’ in Transcript 4. In this discussion, Teacher Carlo started with an analytical dialogic prompt whether people should invoke their rights to say “*No*” when they are subjected to quarantine procedures. Louise responded that “*it is a must*” to obey medical officials if one was recommended for quarantine. Much as she was intending to give a one-sided position on the issue, her elaborations contained explanations which presented two-sided stance when she said that individuals should be responsible to ensure public safety by obeying medical authorities when they were made aware of the possible disease infections . However, associated with this responsibility, she mentioned that aside from informed consent, they should also demand for their rights to be kept in safe conditions in quarantine places such as demanding for proper hygiene, enough and healthy food, and safe and sound environment (Line 2 to 4). Because she mentioned about the “informed consent,” Teacher Carlo was prompted to ask an analytical question about the necessity of informed consent in prior to subject to quarantine. At this stage, Francia mentioned that informed consent is no longer required but instead, ones awareness of his case will be sufficient to accept the responsibility of allowing himself to be subjected to quarantine procedures. However, she emphasized supportive statement to Louise claims that coupled with ones’ responsibility to be quarantined makes him demand of proper treatment which was further supported by Jacob and Carl. Teacher Carlo was quick to respond that proper treatments are usually ensured in quarantine areas

and as such, Gil initiated to establish the collective consensus (Line 17 to 20) by summarizing the significant points mentioned by Francia, Jacob, Carl, and Teacher Carlo in the previous dialogues. Matthew challenged the consensus given by Gil when he introduced the issue on 'freedom' which can be associated to the quarantine procedures. Thus, in Line 22, Teacher Carlo asked him to elaborate on this to which he responded with another two-sided argument about the rights and responsibilities associated to the exercise of one's freedom which can be synonymous to the rights and responsibilities of individuals recommended for quarantine procedures (Line 23 to 27).

The lines of thought in the transcript which illustrated the students' expressions of their argumentative agency that more than learning content, engaging in scientific discourse requires one to be able to defend his claim. In the process of acquiring these skills, they should be subjected to two-sided positions as part of their learning process in preparation for their future when they will be facing the realities which require them of expressing their scientific views about the wonders of science. Dialogically scaffolded by Teacher Carlo, they collaborated and converged their ideas to achieve a consensus, as much as they were made aware of both sides leading them to a productive forum of learning with understanding and achieving conceptual development through a series of interactive and discursive exchange of ideas in an argumentative learning environment.

Illustrating the contingency phases that occurred in Teacher Carlo's class, a simple constructive map was constructed (Figure 6). In the map, it can be illustrated that as they tried to converge their ideas in the contingency phases, their expressions of argumentative agency was full of constructive roles which either support or provide reasons to the previous arguments. With the neutral dialogic scaffolding prompts of Teacher Carlo, their neutral and responsive statements led to the series of social interactions grounded on the idea of joint negotiation and

shared thinking. As they listened and understood the fresh and two-sided positions of their peers, they clarified their thinking, explored how these may relate to newly-presented ideas, and started aligning their conceptual knowledge to the new ones to reach an intersubjective position with their teacher and their peers.

In this argumentative map, several chains of reasons were shared with different constructive opinions as students tried to support each other's claims thus, limiting their expressions of counterarguments and rebuttal statements. It can also be noticed that at the middle of their constructive dialogic exchanges, Teacher Carlo tried to increase their expression of argumentative agencies (Dialogue 5). Despite of this, students were still expressing supportive argumentative agencies using varied opinions related to the topic. Based on the arrows which signify the direction of utterances, the critique type of argumentative agency (challenge) was expressed (Ces counterarguing Jam's opinion). However, the series of utterances that followed were still supportive of either Ces' or Jam's dialogues.

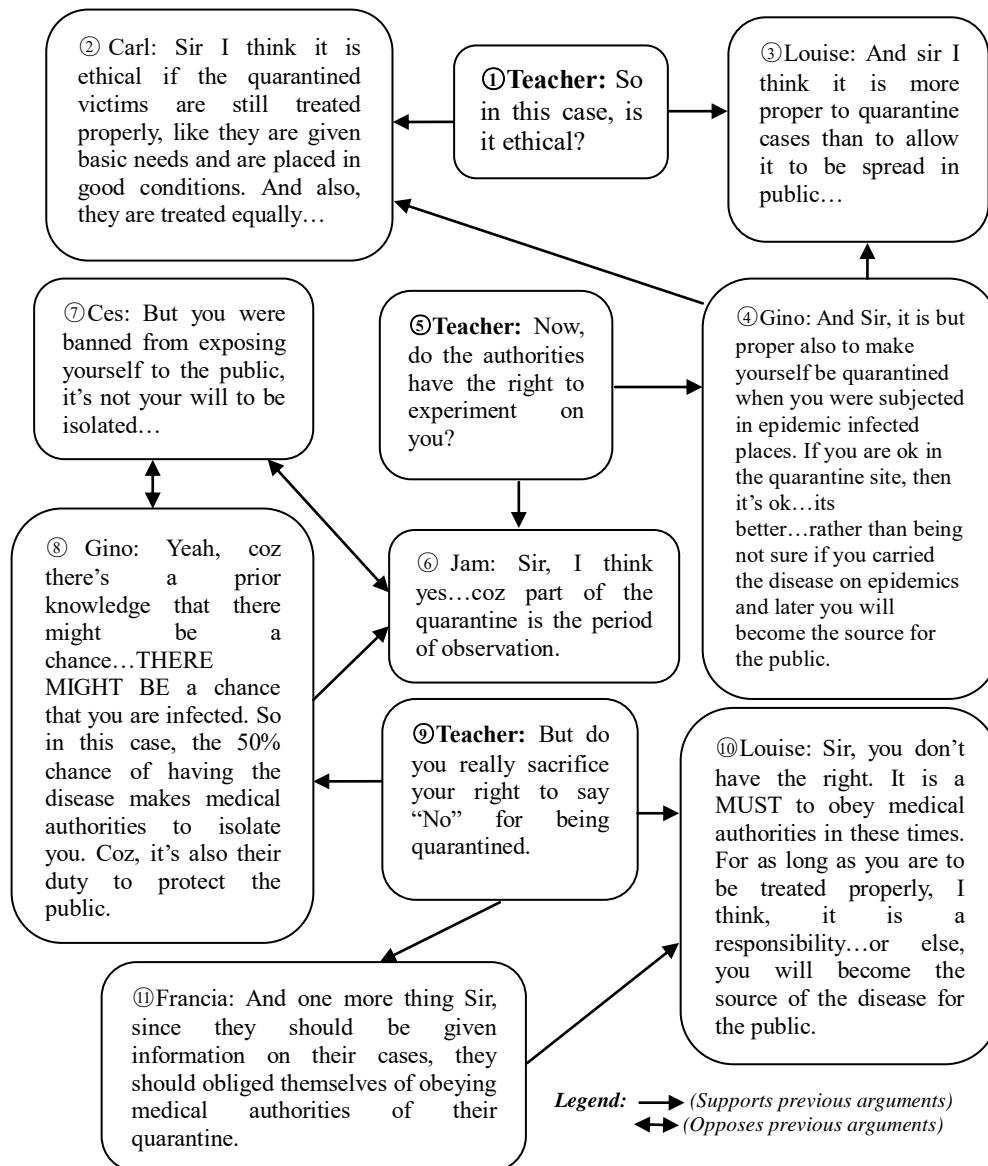


Figure 6. Simple constructive argumentative map in the SSI-based class with students expressing both constructive and critique types of argumentative agency.

In the discussions that took place in Transcripts 3 and 4, it was clear that students were aware that their teacher was trying to elicit their neutral stands on the issue that was presented to them and along the way; they were prompted with two-sided perspectives. As such, as they responded with explanations using their prior knowledge and became aware of the nature of argumentation that their teacher was

trying to establish in their argumentative discussions. Moreover, approaching consensus prompted them to express more of their constructive argumentative agency through reasoned and supportive statements.

It seemed clear that through this, students understood the minds-on processes of inquiry as they recognized the value of expressing their argumentative agency using their prior knowledge through language. Moreover, as language in the form of argumentation was their dominant mode of knowledge acquisition and construction, they were sensitive to the dialogic scaffolding of their teacher which tried to develop their complex understanding of science content in the form of neutral argumentative discussion that converged into a shared intellectual endeavor.

***Combined conceptual and reflective responses in the dialogic inquiry.***

Questioning continues to be effective means of establishing oral argumentation in class. As such, students are usually aware that when they enter their classrooms, they will be subjected to various questions that may elicit their prior knowledge, test the depth of their knowledge, and challenge them to explain their positions on critical points in the discussions. In a traditional classroom however, the use of questions were usually abused by most teachers and simply, they used questions to test the bits and pieces of scientific knowledge of their students with the desire to obtain immediate and pre-determined conceptual answers. In Teacher Don's class, because of his initial plan to frame his biology class towards argumentation, he was able to provide open-ended and reflective dialogic prompts to which the students were receptive enough to respond with varying viewpoints either from their practical or conceptual scientific knowledge. It followed therefore that their responses were aligned to the intentions of Teacher Don to make them accomplish most of the significant learning points of their discussion in a series of discursive dialogue that integrated the learning of concepts behind the occurrence of scientific phenomena. In the process, they harnessed the power and utility of language in their argumentative discussions as the dynamic tool of meaning-making; available

with its capacity to connect the construction and pursuit of formulating reasoned arguments. Through their responses to Teacher Don's conceptual and reflective questions, the inquiry process that occurred in the classes led to the tight connections of teaching and learning that is essential in the dialogic co-construction of knowledge in the enterprise of inquiry.

Transcript 5 shows the students' expressions of argumentative to participate in the discussion through their combined conceptual and reflective inquiry as a response to Teacher Don's argumentative dialogic scaffolding prompts. In Transcript 5, the classroom argumentation started with the conceptual dialogue of Teacher Don on the sticky nature of mushrooms to which Bryan was able to give a quick response that their stickiness can be attributed to their moist nature. Much as the Bryan's response was recasted by Teacher Don, the trajectory of the discussion was suddenly shifted to the obvious visibility of mushrooms in larger quantities when thunder and lightning comes because of Dianne's and Billy's conceptual and constructive statements (Lines 5 to 7). As they expressed their argumentative agency, their reflective statements were supportive of each other and prompted Teacher Don to also shift the lines of discussion. Thus, as they were prompted to state their opinions regarding this phenomenon, Dianne was responsive to the cue of reading directly from her research notes the explanation for this. From her notes, she was able to bring into the discussion the role of the electrical energy that seemed to excite the hypha of mushrooms during thunder and lightning season making them appear in more quantities compared to the fine weather days (Line 12 to 13).

As Teacher Don was quick enough to identify the significant ideas from Dianne's readings (emphasis on hypha), Mila was prompted to express her argumentative agency to reason out about the role of hypha as the site of storage of fruiting bodies which are responsible for reproduction in fungi. Lina was also able to express her constructive argumentative agency when she related the fruiting

bodies to spores in plants. These series of constructive and conceptual students' expressions of their argumentative agency were continuously recasted and acknowledge by Teacher Don so that Jenn was able to relate spores to pollen grains (Line 19) which are responsible to produce flowers as identified by Richard (Line 21). In this series of interactions, the students were already able to enumerate most of the plant parts which are important in the process of reproduction. Thus, when Teacher Don summarized these, they became responsive to link their prior knowledge to relate the roles of spores and pollen grains to the functions of hypha in the fungi body— the parts which are excited by jolts of electrical energy during lightning and thunder. Randy therefore was critical enough to express his argumentative agency to reason out that lightning will bombard the hypha (Line 31) making Jena express her supportive statement mentioning that the bombardment of hypha may lead to explosions and scattering of spores which is the reason why there are more mushrooms during stormy days compared to fine days (Line 32 to 33). However, since Teacher Don noted in the earlier statements that this phenomenon has not yet been established through empirical studies, he emphasized at the end of their discussions that these are all products of their associations so that Jim expressed his resolution to wait for further studies from scientists in order for them to establish their claims (Line 37).

Mapping the patterns and trajectories of the students' chains of ideas as expressions of their argumentative agency, a complex conceptual argumentative map can be produced (Figure 7). This map is characterized by approximately ten students whose ideas were expressed mostly through the constructive argumentative role such as reasoning out or support. Moreover, most of their ideas progressed from conceptual to reflective which mirrored the dialogic scaffolding practices of their teacher. It can therefore be inferred that in the contingency phases of Teacher Don's class, their knowledge construction started from introduction and understanding of the concepts to applying these concepts through the dynamic

interplay of their conceptual-reflective question and response interactions.

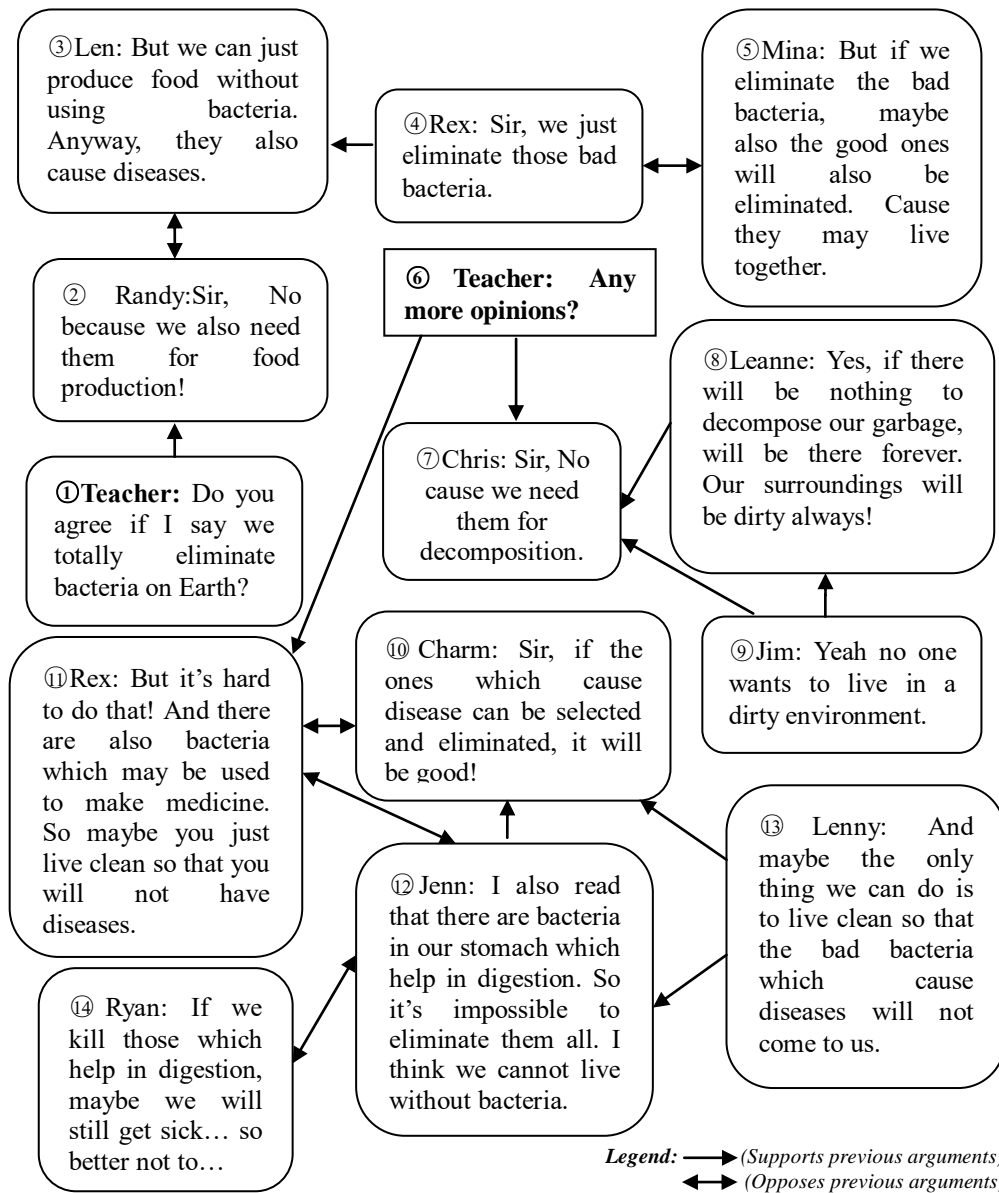


Figure 7. Complex conceptual argumentative map in the contingency phase of the GPHS-Regular Biology Class.

As a usual prompt in Teacher Don's class, their discussion started with either conceptual or reflective questions. In the argumentative map in Figure 6, he started with a reflective question whether the students agreed or not on the total elimination of bacteria on Earth. Randy was prompted to respond with his



argument on the impossibility for the total elimination of bacteria because people need them for food production. This was followed by the challenging counterargument of Len when she said that since they (bacteria) also cause diseases, people can think of other means for food production to justify her claim for the total elimination of bacteria.

Considering the arguments of Randy and Len, Rex suggested the possibility of eliminating only the pathogenic bacteria. However, this was challenged by Mina with her claim on the impossibility for selecting and eliminating only the pathogenic bacteria as they might co-inhabit similar environments with the non-pathogenic ones. Without any follow-up arguments, counterarguments, or rebuttals, the discussion ended but Teacher Don extended the argumentation by encouraging more opinions which prompted Chris to introduce the role of bacteria in decomposition (Dialogue 6). Chris' argument resulted into the participation of several students (Leanne, Jim, Lenny, Jenn, and Rex) with supportive statements which included topics like proper hygiene instead of totally eliminating bacteria and the importance of bacteria in digestion. At this stage, Charm raised her argument by resurfacing the possibility of eliminating pathogenic. Rex challenged and counterargued this claim with his justification on the difficulty of the proposal.

Based on the discussion in the argumentative map in Figure 7, it can be observed that though conceptual dialogues limited the students' expressions of argumentative agency, Teacher Don's reflective dialogues were also effective enough to probe further the discussions in an attempt to encourage students' participation. As such, despite the students' short and content-based responses, Teacher Don's dialogic prompt to probe further and his avoidance of the IRE sequence of classroom interaction (Dialogue 6) deepened the interactions. Based on the lines of thought, instead of just discussing the functions of bacteria in food production, the students were able to extend the application of their lesson on

bacteria to waste decomposition (Dialogue 7), drug production (Dialogue 11), digestion (Dialogue 12), and maintaining proper hygiene (Dialogue 13).

Based on the discussions that took place from Transcripts 5 and 6 and on Figure 6, it can be inferred that the students' positive response to the dialogic scaffolding made them co-constructors of their knowledge while developing their argumentative skills. It can also be observed that as they recognized the combined conceptual and reflective dialogic prompts of their teacher, they were able to engage in a more extended dialogic exchange. Most of the time, their responses served as signals to their peers for more ideas. Because their teacher valued their possessions of innate capacities to participate in the discussions, their willingness to express their argumentative agency were not inhibited but instead, were scaffolded in alignment to their prior knowledge and argumentative skills. As they received questions within their zone of proximal development and in consideration of their local knowledge, their motivations to participate in the discursive exchange were stimulated. This aligns to Boyd and Rubin (2006) who claimed that dialogic talk flourished when teachers' questions were anchored to the students' level of argumentative capacities.

*Gradual increase of unsolicited responses as a positive recognition to teacher's reinforcements.* Reinforcements continue to be one of the methods in managing certain groups of people. These also apply to the educational settings and were observed from the dialogic interactions that took place in the Special Science-Regular Biology Class in this study. In this class, as students felt the important contributions of their discursive participation and from the constant recapping and recapitulating contingent dialogic prompts of their teacher, they felt the need to produce more elaborations and supplement their claims with evidenced-based ideas from their prior knowledge. Due to this recognition, their dialogic interactions gradually increased with unsolicited responses and they were able to utilize the scientific terms which they learned from previous lessons. Moreover, they started

to establish awareness on the interrelated nature of their scientific knowledge construction and reconstruction. They usually understood Teacher Mara's contingent recapping and recapitulating as a form of reward for their contributions of ideas in the discussion thus making them more motivated to participate. They did not feel that they were lacking of argumentative skills, but instead, they were treated as mutual contingents in the scaffolding of their expressions of argumentative agency.

In Transcript 7, their discussion started with an analytical dialogic prompt which elicited their ideas on the significance of studying the pattern of inheritance in humans. Dianne was prompted to respond with her idea that studying the pattern of inheritance makes them understand the inheritance of human diseases. As their discussion went along, her ideas became a contingent dialogue to Teacher Mara for another reflective dialogic prompt asking, *"do we really need to know this."* Having similar line of thinking with Dianne, Leslie continued to defend Dianne's previous claims by saying that knowing the inheritance of diseases makes them cautious about their health. Again, this response prompted Teacher Mara for an analytical contingent dialogue when she asked them if they can still do something about their inherited diseases despite knowing the patterns of inheritance (Line 6). Still firm in supporting the previous claims of Dianne and Leslie, Linda explained that knowing ones inherent disease would make one to be conscious about lifestyle to which this was again supported by Kevin an example due to his direct exposure to such diseases because of the diabetes of her aunt (Line 9 to 11). He elaborated his reasons saying that her cousins' knowledge of their Mom's diabetes made them cautious about their sugar intake because of the possibility of diabetes onset to them because of their Mom.

It can be noted in these transcripts that the discussion involved reflective dialogic interactions to establish the reasons why the patterns of inheritance should be studied in high school biology classes. Based on the discussions, most of the

reasons were all provided by the students in a form of responses to the alternating analytical and reflective reinforcement dialogic prompts of their Teacher. In the transcript, it can also be observed that the teacher never gave any reason but she continued to dialogically scaffold the students' expressions of argumentative agency through open-ended, reflective, and analytical dialogues.

Similar scenario can be observed in their conceptual discussion in Transcript 8. The discussion started with Teacher Mara's conceptual dialogue which elicited their participation to inspect the pedigree. Kyrie was quick to respond with a clarification question on why the pedigree contained two healthy offspring. This question was addressed to their teacher but Teacher Mara did not give any response making other students Lea and Gina to inspect the pedigree in reference to Kyrie's question. This meant that the students were already used to unsolicited responses when teacher Mara silenced herself during discussion. As the students were allowed to express their challenger, evaluator, and clarifier roles, their teacher noted the critical points they raised and this served as contingent dialogues for her to formulate more conceptual dialogic prompt as she recapped their responses such as in Line 6 of Transcript 8. As a response, Kyrie kept on questioning the pedigree using his knowledge on expected ratios. Might as he supported his reasons with scientific background knowledge, Matthew was prompted to clarify everything for him based on his understanding. It can be noted again that Kyrie's questions (Line 7) were directed to Teacher Mara but with unsolicited response, Matthew was quick to answer when he gained his confidence in answering the question and expressing his argumentative agency. In order to reinforce the knowledge of Kyrie about ratios, Teacher Mara acknowledged his responses making him more confident in continuously clarifying his doubts. Because of this, the discussion continued and Pearl was supportive enough to explain and summarize the previous reasons that were given from the start of their discussions in acknowledgement of his classmates' various points of view.

Compared to Transcript 7, the discussion in Transcript 8 was mostly conceptual. However, as the students were engaged in the process and were responsive to their teacher's dialogic prompts, they were made to accomplish their lesson objectives as they expressed both of their constructive and critique argumentative agency. Much as some of their ideas were similar to each other, they recognized from their teacher's dialogic prompts that there exists a multiplicity of perspectives present in any response. As they were allowed to present justifications from different perspectives to which their lesson is connected, their responses became unique from each other with different dialogic roles indicative of their expressions of their various argumentative agency.

Emphasizing on their unsolicited responses without heated arguments, it can be inferred that the dialogic prompts of their teacher were developmentally appropriate and as they expressed their argumentative agency, they did not impose their positions on others which preserved the harmony of the argumentative learning environment. Much as they expressed critic roles, their queries converged in the end with supportive statements and facilitated their student-centered knowledge construction. To illustrate these similar scenes in the classroom, the series of supportive dialogic roles as an expression of students' argumentative agency in the Special Science-Regular Biology Class produced a simple constructive argumentative map (Figure 8).

In the content-based discussion in Figure 8 which was obtained in the last portion of the discussion in Transcript 16, students were encouraged to answer the previous question when she asked, "*who can answer that*" in Line 11. This elicited a series of constructive responses which resolved the pattern of inheritance of the X-chromosome and how it affected the inheritance of diseases. It can be noticed that students' answers were all supportive of each other and even with multiple perspectives, they were able to resolve and initiate the formation of their knowledge. At the end of the chain of discussion, Teacher Mara even encouraged

Jason to present evidence to strengthen their claims by asking for example (Dialogue 8).

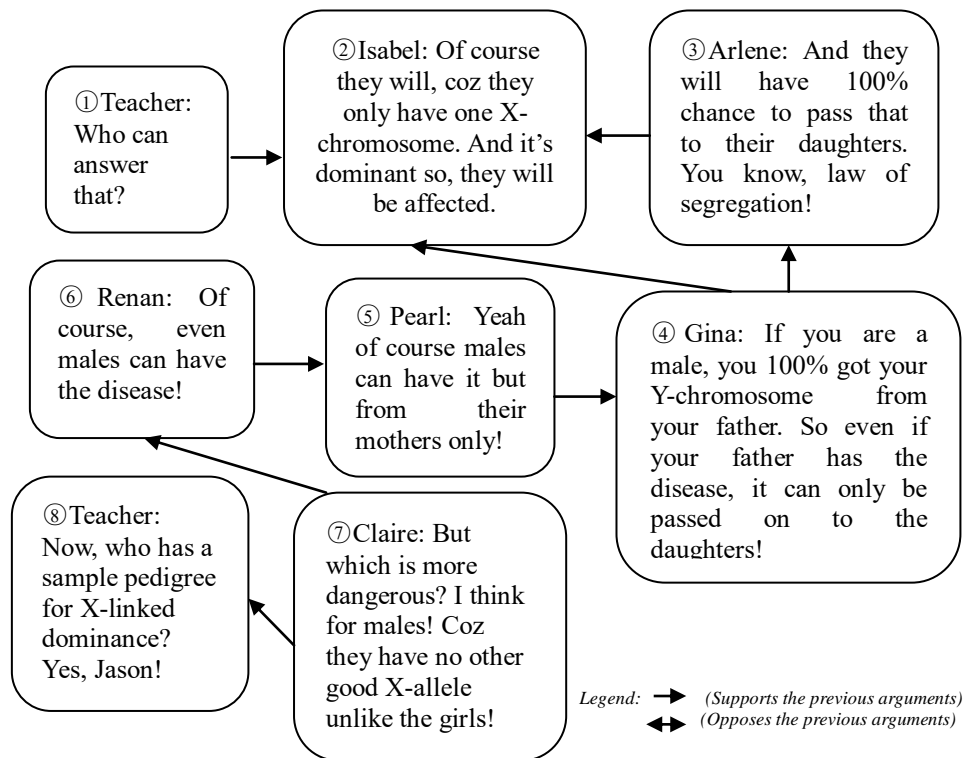


Figure 8. Simple constructive argumentative map in the content-based class indicative of mostly supportive argumentative agency that was expressed.

### 5.3.2. Theme 2: Use of science concepts, willingness take part, and recognition the advantages of turn-taking in the fading phases

From the perspectives of the sociocultural principles of learning, students' oral communicative abilities serve as mediators for their self-regulation, learning and thinking process (van Oers, et al., 2008; Whitebread, et al., 2013). As learning can be mediated through dialogue, it is therefore important to invest on their oral communicative skills as a foundation for the success in developing their processes of science particularly on argumentation. Considering the dynamics of dialogic exchange in an argumentative classroom, it is therefore important not only to focus

on the formal aspects of communication but more so of the quality of the argumentative dialogues students bring into the discussion. Evidence, as regarded to be the most significant aspect in an argumentative statement should therefore be the main focus in classroom argumentation.

Through dialogic scaffolding, this can be done starting from the contingency phases to the fading phases in which the dynamic assessment of their oral communication skills and the quality of their arguments are constantly being monitored and scaffolded. This was observed in this study as students expressed their argumentative agency in both the contingency and fading phases in response to their dialogic scaffolding practices. Particularly in the fading phases, students' expressions of their argumentative agency were evident in that they became aware of the turn-taking episodes of their unsolicited responses to the teachers' dialogic prompts. Moreover, they were able to express both of their constructive and critic argumentative agency using scientific concepts that established the links of their topics to previous ones.

In the SSI-based classes, students' argumentative statements contained various application concepts in response to the teachers' initiation of reflective inquiry. As such, alongside with the development of their communicative and argumentative skills, they became aware of the relationship of science knowledge and the aspects of society during the turn-taking episodes of peer-to-peer interactions. In the content-based class, as students continued to identify the related science concepts associated to their current topics for discussions, they facilitated themselves to appreciating the holistic nature of scientific knowledge construction as they identified the connections of their current topics to previous ones.

It can also be observed that during their "wait time" for the turn-taking episodes, they were able to listen and articulate the elaborated and multiple perspectives of their peers which facilitated their further formulation of arguments, counterarguments, and rebuttals on the previously stated dialogues. Their

awareness that their ideas can anytime be refuted by others indicated that they were open to the nature of scientific enterprise that all ideas can be refuted once significant evidences were formulated. In the process, as they recognized the turn-taking process of their argumentative and dialogically-scaffolded discussions, they were able to collaboratively negotiate ideas and establish consensus that were within the realms of their developmental thinking skills. Therefore, their learning was shifted away from the usual “guessing of what the teacher is telling” in search for a right answer.

With more participants during the discussions in the fading phases, their dialogic exchange ascribed them the responsibility to achieve the lesson objectives or to achieve consensus with symmetrical power structures of dynamic exchange of ideas rendering their argumentative discussions with exploratory talk in an unpressured and uncontrolled environment. In the fading phases of the classroom discussions in this study, four themes represented the responses of the students to their teachers’ dialogic scaffolding practices namely: immediate application of the lesson concepts to daily lives and recognition of the importance of turn-taking in the dialogic exchange in the SSI-based classes and recognition and more use of scientific concepts and willingness to take responsibility to respond to personal and/or peer queries in the content-based classes (Table 10).

*Immediate application of the lesson concepts to daily lives.* This response and expression of augmentative agency was observed in the STE-Biology Elective students of Teacher Loida. As their teacher framed their argumentative discussion towards the SSI-based approach, it was obvious that they also responded and expressed their argumentative agency using practical knowledge that was linked to their current lessons. According to Presley et al., (2013), SSI-based instruction can be interesting if discussions start with and centered on socioscientific issues. This was usually observed in the STE-Biology Elective when students became excited to bring into the discussion what Teacher Loida had assigned them as their reading



and research tasks. As they were prompted to make decisions on the issues presented to them, they became active in finding for evidences from various media sources that backed-up their claims during their sharing activities in class.

As their Biology Elective class was framed towards discussing socioscientific issues, their ideas were framed to practical reasoning where evidences for their claims were framed from situations which called them for decisions about daily existence such as deciding for in-vitro-fertilization and personal use of stem therapy to cure diabetes illness. Using these as examples, learning for them was grounded on practical knowledge. Practical knowledge in this study means that the students' lines of reasons were derived from personal experiences and local knowledge that have immediate applications associated to their science concepts discussed through dialogic inquiry. As such, their learning process became authentic with the immediate and direct application of their science topics to daily lives.

During their dialogic inquiry, expressing their arguments and argumentative agency became interesting because they used stories which illustrated their direct experiences or phenomena which they can possibly or directly experience. Through these, they became motivated to participate in the argumentative dialogues by recalling pieces of practical knowledge they have been exposed to. Meanings of concepts were derived from their practical examples and knowledge construction spiraled from simple to abstract concepts which started from the contingency phases of their argumentative discussions. Thus, science learning became experience-based through collective negotiation and flexible reconciliation of reasoned arguments as they recognized the uniqueness of their own experiences.

In their SSI-based lessons, their classroom became a site of wonder which stimulated their argumentative agency to take-turns in questioning each other with pleasant behaviors. Their dialogic questions can be characterized to be aligned with

Chin and Brown's classified wonderment questions which include: 1) comprehension questions which typically sought explanations of something not understood, 2) prediction questions such as "What would happen if..." which involved a variety of speculation or hypothesis-verification, (c) anomaly detection questions where the student expressed skepticism or detected some discrepant information or cognitive conflict and sought to address the anomalous data, 4) application questions in which the students wondered of what use was the information that they were dealing with, and 5) planning or strategy questions where the students were temporarily stuck and wondered on how best to proceed next when no prior procedure has been given.

In Transcript 9, students' excitement to participate in the discussion can be observed. It can be noticed in the early stages of the discussion that despite Teacher Loida's conceptual introduction about the process of cloning (Line 1 to 7), the first response of David was immediately the controversy associated to the cloning procedure. This means that, with his reading and research task, he was already prompted about the issue on stem cell therapy and that he initiated to shift away the conceptual discussion towards issue-based. As Teacher Loida was quick enough to appropriate his response about the controversy associated to stem cell (Line 9 to 10), series of reasons came out from four students whose ideas were all supportive of each other using their religious beliefs as the main reasons for the controversy brought by cloning. However, as Teacher Loida sensed that using religion to discuss scientific concepts will immediately halt the dynamic exchange of interactions, she immediately shifted the discussion gear by resurfacing her earlier background information in Line 1 to 6. Through this, there was a significant number of expressed students' argumentative agency in the fading phase from Lines 19 to 33 with nine different ideas from five students who expressed most of their critic type of argumentative agency. For instance, in Line 18, Ryan said that the stem cell therapy procedure is not murder because in the process, only the

blastocyst which is not yet a fully-developed embryo will be taken out. This was challenged by Rem when she said, “*what if you allow it to develop...it will become a baby, a human being!*” With an insistent argumentative agency, Ryan defended his claim using the background information that the blastocyst still has no life that is why, this is the best stage to take out the blastocyst (Line 22 to 23). Again, Rem was equally insistent and she challenged them with her idea of the willingness of others to sacrifice the blastocyst. However, Ryan still defended his claim saying that this can only be done with proper procedure particularly through donation. This was again counterargued by Diana because according to her, not all would want to donate and that according to Kyrie, there is no early detection for the blastocyst stage in females’ bodies. He might have actually meant that because of the impossibility for early detection, it might have been intentional if one allowed the blastocyst to develop and be taken away from her body. This implied meaning in Kyrie’s statement was quickly recognized by Cass (Line 31 to 32) when she said that this can only be done for research purposes which was contested by Grace in the end of the fading phase to which she was able to give follow-up explanation when she was prompted by the teacher to elaborate on it.

In the second part of this fading phase, their discussion continued as their interactions progressed into the medical use of stem cell therapy in Transcript 10. In this discussion, using one conceptual dialogic prompt from their teacher, they were able to take turns in expressing their argumentative agency as they recognized the direct application of stem cell therapy for personal beauty enhancement by making oneself look young, opening up the topic on proper organ donation, equal access of the procedure by everyone, and the possible economic issues of selling blastocysts if the research procedure will be globally acceptable and utilized. It can be observed in this chain of reasons that as they recognized the direct application of their science topics to their daily lives, students were responsive enough to shift their discussions towards SSI-based approach. With prompt questions which

demanded their personal decisions regarding the issues presented to them, their basic knowledge were enhanced by their research tasks which gave them hints to link the socioscientific issues to practical and social knowledge that they were aware of. It can therefore be claimed that as students were allowed to for intra-thinking activities in the fading phase in a dialogically-scaffolded SSI-based class, their learning process made them strengthen their analytical thinking skills of making inferences and generating reasoned arguments such as in the chains of their dialogic exchange in Figure 9.

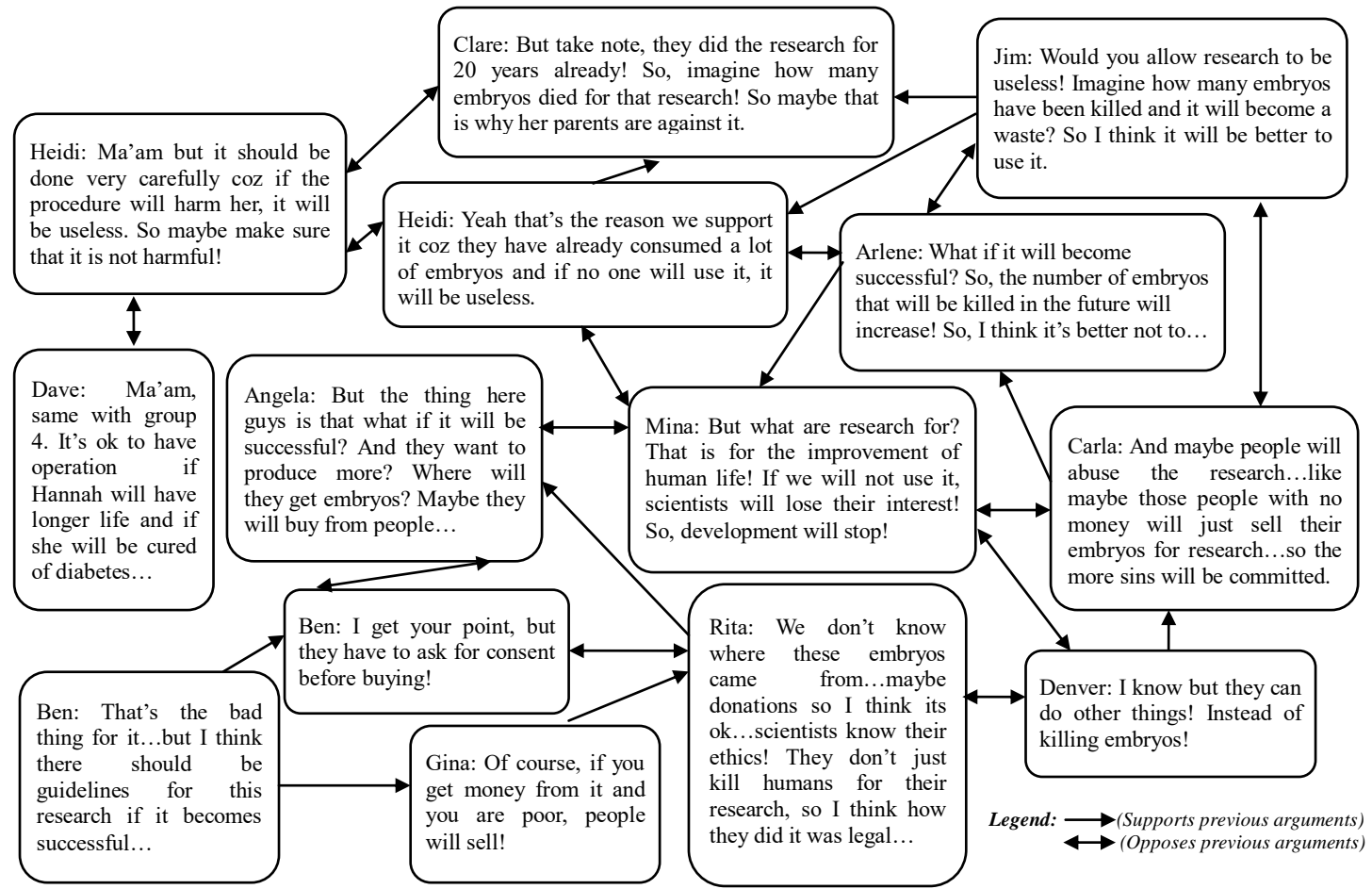


Figure 9. Complex multi-inferenced argumentative map in the SSI-based class showing students' less elaboration but with full autonomy.

In the argumentative map in Figure 9, the first response was from Dave who expressed similar argument with the previous group that they agreed with the stem cell therapy to cure Hannah's diabetes. This was supported by Heidi with a justification that safety procedures for stem cell therapy should be ensured or else, Hannah's surgery will be useless. Dave's argument and Heidi's justification were opposed by Clare with an evaluative dialogue telling that with 20 years in the research process, a lot of embryos were already used and that maybe the reason for Hannah's parents not to support the treatment. In her dialogue, Clare was assuming that Hannah's parents were against the use of embryos for stem cell research. Taking Clare's counterargument, Heidi strengthened her justification by saying that the more it should be supported in order to give justice to the embryos that were already sacrificed. Jim supported Heidi with his clarifying dialogue that it is better to use products of research like these in consideration of the embryos that were already used.

It can be assumed that Jim was implying that more than the harm, research like these were done to help humanity. However, this justification was again challenged by Arlene when she said that supporting such kind of research will just keep the number of embryos to be used to increase in the future (*"...So the number of embryos that will be killed in the future will increase! So I think it's better not to..."*). This was supported by Carla with her argument telling the possibility of abuse in research when people will start selling embryos to earn money and more sins will be committed. Mina, on the other hand, challenged and opposed Arlene and Carlo when she expressed support to Heidi and Jim with her justification that most research are done for the improvement of the quality of life and that products of research should be patronized to support scientists with their goals for human development. However, this was challenged Denver with his suggestion that instead of 'killing embryos,' if scientists' real aim was the improvement of life, they should think of other methods to avoid the 'sin.' Rita was

trying to pacify the argumentations with her clarifying dialogue stating that without enough knowledge of where the embryos came from and assuming that these were donations would support the legality of stem cell research. However, Rita's dialogue was again challenged by Angela saying that the success of the research would lead to more of its applications, meaning more embryos to be sacrificed which might have been already purchased. The whole class arrived at a consensus when Ben introduced the idea of consent and proper ethical guidelines in both the donation and purchasing processes of embryos (if that's the case) in this type of research.

The complex multi-inferenced argumentative maps were usually constructed from the SSI-based classes for the obvious reason that most of the students' responses as expressions of their argumentative agency where inferential and products of their synthesis on the direct applications of their biology lessons to different social aspects. The map shows more students participating with chains of reasons that were leaning towards socioscientific issues and with varying expressions of their argumentative agency making the patterns and trajectories of their dialogic exchanges more complicated. In the argumentative map, students presented various arguments, counterarguments, and rebuttals, each of their statements playing different roles that sustained the classroom argumentation. Moreover, with multiple reasons for the opposing statements, the argumentative map became more complicated. It can be observed that 14 students with different roles and chains of reasons were able to participate in the discussion as they presented their justifications to their arguments, counterarguments, and rebuttals and as they introduced new or related topics, other students were encouraged to participate in the discussion. This was however, dependent on how Teacher Loida framed her argumentative prompts during the contingency phase of her dialogic scaffolding which progressed into this fading phase.

***Recognition on the importance of turn-taking in the dialogic exchange.***

One of the intriguing features of human communication is the interactional infrastructure it builds on. In terms of argumentation, dialogic interaction is usually preferred compared to the dyadic one. It is also supported by the principles of dialogic teaching and learning wherein discussions must be centered into how ideas flourish from one single open-ended statement that is inviting of various perspectives. This is no different from dialogic scaffolding in scientific argumentation where mentors' dialogic prompts should be interpreted as eliciting various viewpoints which will later converge into one common understanding that is encompassing of the scientific knowledge and competence required of the students to develop.

This was observed in Teacher Carlo's students. They usually waited for other students' to finish expressing their thoughts and they valued the idea of listening for negotiated responses. Turn-taking rules were not really defined among the students of Teacher Carlo. However, as they recognized the signals he provided, for example recapping statements or following up of the newly-introduced terms, students became aware to whom the conceptual or reflective questions were addressed to. However, there were instances when follow-up questions were not answered by the specific students. This was because more knowledgeable ones were able to organize their thoughts and were readily responsive to give their opinions. However, as the discussion proceeded, Teacher Carlo usually initiated to resurface the previous ideas which were given by previous students. As such, students recognized their ownership of the ideas and started to give their reasoned arguments. It was observed that in these instances, students were already more confident as they were able to synthesize their answers from the series of responses which were already provided by others, thus increasing the validity of their claims using organized thoughts.



The success of turn-taking is usually dependent on prediction. In the case of Teacher Carlo's students, they usually imitated the way he enacted turn-taking for his dialogic scaffolding in the contingency phase where they were allowed to express complete thoughts before he uttered his dialogic prompts. Thus, in the fading phases, the interactions became beneficial for the students' gradual ownership of the discussions when they became listeners to others before responding or expressing their claims. In fact, most of them benefitted in such a way that, their waiting time for others' reasons to be expressed prompted them for further reorganization of their opinions.

Another way that this was evident was associating the answers to certain students. Since most of the students of Teacher Carlo were opinionated, it is thus important that he ensured that everyone has a turn in the discussions. There were instances however, that certain students were not responsive to the referenced cues. This is where the value of waiting time comes in. Aside from the verbal cues, students were also responsive of the non-verbal cues whether they take the floor of the discussions or not. It is important to note that students were never silenced in class. As good speakers, they were also good listeners and responsive to non-verbal cues of turn-taking. Thus, it is therefore crucial to develop students' recognition on the value of turn-taking in the dialogic exchange so as not to develop a culture of dialogic competence or monotony of discussions. This can be established in dialogically-scaffolded argumentative discussions when students mirror the actions of their teacher in the contingency phases.

In Transcript 11, during their discussing on 'consent before clinical trials,' the students were actively engaged with their elaborated opinions from the dialogic analytical scaffolding prompt of Teacher Carlo which served as a tool for their dialogic inquiry to occur. It can be observed that as they progressed with their neutral statements which were established from the contingency phase, the initial elaborated claim of Claire in Line 4 to 6 was in consideration of the welfare of both

healthy and unhealthy samples. Turn-taking was evident when she was allowed to finish her response with elaborated reasons by Gina whose ideas supported hers. Ken challenged their ideas but she recognized turn-taking events and was calm enough to express her challenging response to Claire and Gina (Line 9 to 10). After allowing her to finish her challenging responses, Gina expressed her constructive argumentative agency to continue reasoning out in behalf of her and Claire's claims. In the succeeding discussions, Roman challenged all of them by raising and resurfacing the real target of their discussion which is 'ethicality of consent.' After finishing his statement, Jim defended the previous claims of Claire and Gina which challenged Roman's responses when he said that 'giving consent is already a method that ensures ethicality. With more supportive ideas, Gil waited for his turn to express his summative and elaborated responses from Line 15 to 18. Despite long answers, Yvette managed to wait for her turn in Line 19 to 21 to support all of the responses of Claire, Gina, Jim, and Gil saying that consent forms must clear out all issues of possible deception by properly indicating all necessary information the participants have to know before signing the consent forms. She further mentioned that for clarity purposes, researchers are obliged to explain these agreements properly the participants before asking for them consent. With the turn taking events in the dialogue interactions, students were able to resolve the issue by themselves in Line 22 with Gil's responses saying that with proper explanation of the agreements for both health and unhealthy respondents in clinical trial experiments, the ethicality issues are cleared out.

Ensuring proper turn-taking events in this class was also observed in Transcript 12 during their discussions whether they are in favor of genetic engineering of humans, plants, and animals. To ensure proper turn-taking, Teacher Carlo explicitly addressed the question to Justin by mentioning his name. Thus, Justin explained his arguments that with the case of humans, he was not in favor but for plants and animals, the issue was different. This statement implies neutral

decision which was established from the contingency phases. With similar neutral decision but with a slight contradiction to Justin, Gil allowed him to finish and expressed his augmentative agency to evaluate Justin's statement. Ana was quick to understand the implied meaning from Justin and Gil's arguments in Line 6 to 8 when he mentioned the issue of 'playing God.' In contradiction to Ana's statement, Louise expressed her neutral stand when in Line 9 to 10 when she said that the process of genetic engineering is a product of cognitive abilities which was provided by God, so there is no issue when one uses these. Resolution started when Albert mentioned that genetic engineering can be beneficial for humans when done with plants and animals. This implied another neutral decision which progressed from the contingency phase and was expressed with proper recognition of turn-taking. In his arguments, through genetic engineering, humans are benefitted when it is used for plant and animal production that would solve social issue like famine. With elaborated and supportive response, Grace expressed her favorable decision to conduct genetic engineering using the explanations of Albert. After waiting for her to finish, Carl mentioned about IRRI in the Philippines in Line 17 to 19 which illustrates that product of the studies conducted in IRRI is the genetic engineering of rice which has been useful throughout the years in resolving issues of rice production not only in the Philippines but in all rice-eating and producing nations.

Based on the dialogues, Transcripts 11 and 12 illustrated the importance of turn-taking events in a dialogic inquiry. Particularly in Yvette's summarized response in Transcript 11, as everyone became keen listeners and patiently waited for their turns to talk, she was able to summarize all the significant points from her classmates which led the formation of her dialogic consensus (Line 19 to 21). Similarly, this happened in Transcript 12 with Albert's consensus statement in Line 11 to 13. With his consensus response, series of students like Grace, Carl, and Gil established their final decisions which answered the initial analytical dialogic prompt of Teacher Carlo at the beginning of this fading phase. It can be noticed in

this dialogic exchange that students' expressions of their argumentative agency were filled with inferences and opinions about social issues. Moreover, as their dialogic exchange progressed, varied dialogic agency were expressed both from constructive and critic types of students' dialogic roles. Thus, mapping this dialogic exchange would yield to a complex multi-inferenced map which can be shown in Figure 10.

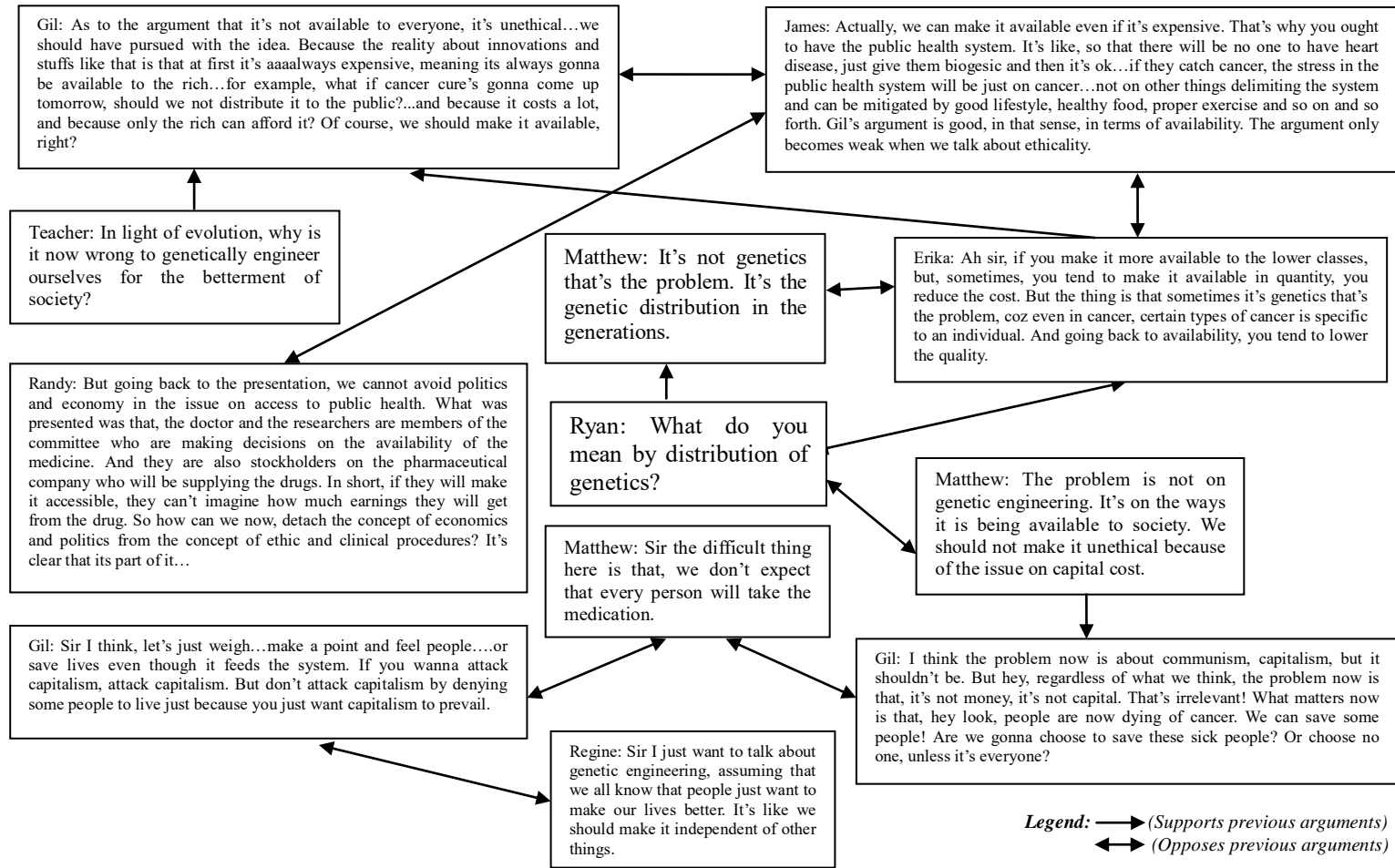


Figure 10. Complex multi-inferenced argumentative map with students' elaborative and autonomous expressions of argumentative agency.

In the argumentative exchanges in Figure 10, Teacher Carlo's analytical question on 'why is it wrong to genetically engineer humans' leveraged students to argue on several social issues such as ethics presented by Gil, the inequality for the access of drugs (due to differences in financial capacities) and the role of the public health system by James, and economic problem by Matthew and Gil. Argumentative scenarios like these implied that their understanding on the immediate applications of their bioethics topics led them to express more of their argumentative agency. Moreover, during the observations, the students never failed to raise the issue of ethics in any of their discussions. This means that students were keen in applying their ethics lessons in most of their discussions. This supports the claim of Teacher Carlo that the argumentation that was taking place in their classroom served as his method of assessment on the performance of his students.

As mentioned earlier, the framing of the teachers of their instructional approaches to their biology classes contributed to the students' expressions of their argumentative agency in response to their dialogic prompts. In the content-based class, the conceptual dialogic prompts of the teachers led to the complex constructive argumentative maps. Much as the combination of the two types of argumentative agency were expressed (constructive and critic) by the students, their discussions were mostly focused on conceptual knowledge so that there was a dominance of the expressions of the constructive types of argumentative agencies. In contrast, the complex multi-inferenced argumentative maps were usually constructed from the SSI-based class. As the teachers framed the co-construction of scientific knowledge from various issues related to the scientific facts, they were able to provide analytical and reflective dialogic prompts which resulted to divergent ideas. Through their analytical and reflective dialogic prompts, students were prompted to analyze, synthesize, or evaluate their knowledge and the occurrence of counterargumentative statements increased the variety of students'

expressions of their argumentative agency.

*Recognition and more use of scientific concepts.* In a constructivist learning environment, science educators are very much concerned with the development of knowledge rather than on the transmission of knowledge. As such, learning calls for the active participation of students in personally understanding the interrelated concepts. In this study, this was evident in the classroom of Teacher Don through knowledge integration as students built scientific concepts from layman's terms. It can be observed in most of their discussions that the alternating conceptual and reflective questions that were given to them increased in complexity which originated from everyday knowledge. Because of the dialogic scaffolding prompts of Teacher Don, the simple concepts such as those pertaining to the dampness of mushrooms progressed not into the formal definitions of spores to recalling the pollination process and identification of the reproductive parts of a flower. Through this, learning was leveraged into the development of formal scientific knowledge which originated from practical ones.

Dialogic scaffolding in the fading phase of Teacher Don's class can be inferred to result into conceptual understanding. Based on the dynamic interactions of their dialogues in the contingency phases, students intelligibly made sense on the meaning of their lessons as they incorporated their new assimilated knowledge into their cognitive structures. Thus, as they were allowed to discuss on their own in the fading phase, they began to realize that most of their fragmented everyday knowledge can be associated to scientific knowledge and that dilemmas can be resolved during their expressions of argumentative agency. As their knowledge was formed through their dialogic exchange of ideas, their misconceptions were cleared as meanings were negotiated through collaborative argumentation. Moreover, their knowledge can be associated to dialogic conceptual mapping as they took turns in doing free-word associations through dialogic interactions.

Discussions in Teacher Don's class usually started with simple terms which were familiar to students. This might be his way of stimulating the expressions of their argumentative agency by simplifying terms so that they are able to relate to him. Thus students answered with simple terms at the start and slowly increased their use of scientific terms as they went along with their discussions. For instance, in Transcript 13, the fading portion of their discussion started with the reflective dialogic prompt of Teacher Don when he told them to imagine grouping organisms on Earth. The initial response of Martin was simply grouping organisms with plants and animals (Line 5). However, as more students expressed their argumentative agency, the term 'virus' surfaced in the discussion from Dondie's response in Line 6. Thus, the class started to evaluate the initial grouping which Martin has suggested (plants and animals). Moreover, with the introduction of the term 'virus' by Dondie, Kevin was prompted to include the term 'bacteria.' At the end of the discussion, considering plants, animals, and bacteria, this became the final decision of Rem for the grouping task they were asked to do.

Similar case occurred in Transcript 14 with their dialogic tasks to identify the similarities of plants and algae. The series of responses which indicated the students' expressions of argumentative agency included the terms chlorophyll which made the class realize the life in aquatic environments with the help of algae which supply food and oxygen to the marine fauna. The discussion commenced with their reflective thinking which extended the role of algae for food chain not only to marine organisms but to humans as well. Thus, at the end of their discussion, they were able to recall the term for the feeding relationship to refer to a formal scientific term, food chain.

Based on the discussions that occurred in Transcripts 13 and 14, it can be noticed that the alternating conceptual and reflective dialogic prompts of Teacher Don resulted to simple and unelaborated responses of the students. Thus, mapping similar discussions would yield complex conceptual argumentative maps with a



combination of constructive and critic roles of the students. At times, due to the content-focused discussions, the interactions in the fading phases would easily be ended with just few students expressing their reasons and argumentative agency.

In content-based discussions like these, a simple linear argumentative map can be formed just like the map that was constructed in the SSI-based class of Teacher Loida when their discussion was focused on building up the scientific knowledge behind the issues they were discussing (Figure 11). With conceptual ideas converging towards a conceptual understanding of concepts, students' expressions of argumentative agency were mostly constructive with mostly supportive roles which built the meaning of scientific concepts and identified the interrelated concepts associated to their current topic.

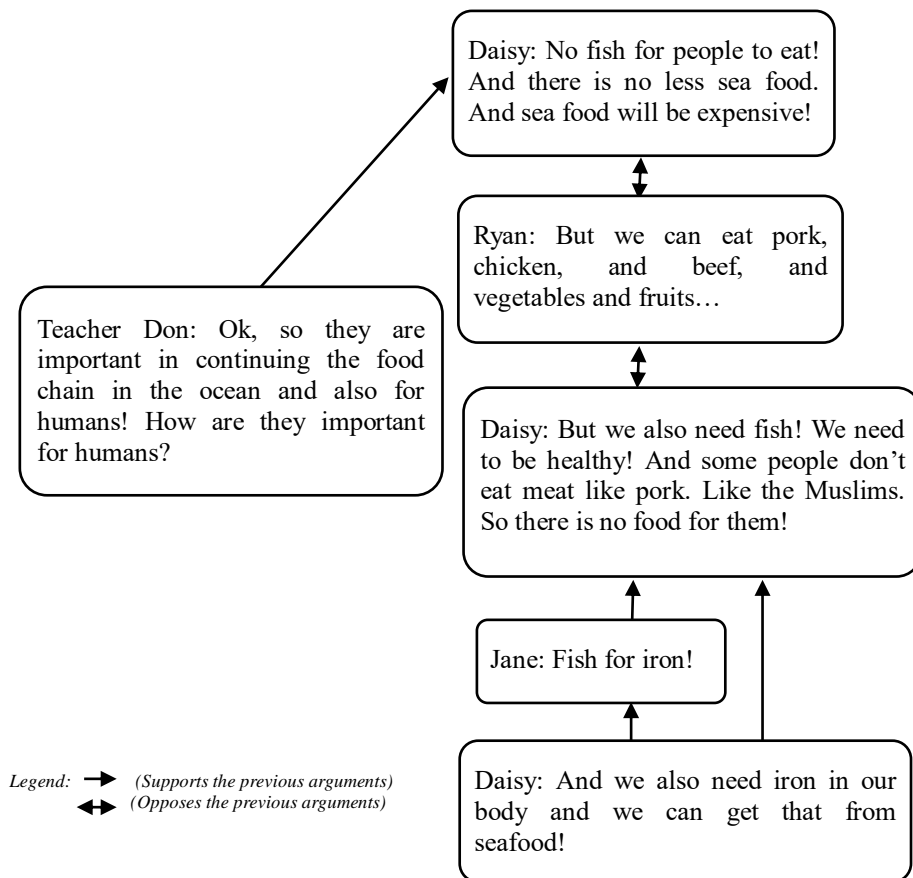


Figure 11. Simple linear argumentative map in the content-based class with a combination of constructive (support) and critique (challenge) argumentative agencies.

In the argumentative map in Figure 11, students' interactions showed less counterargumentative statements which limited their expressions of argumentative agency. Using a reflective dialogue whether algae are important in the food chain relationship in the ocean or not, Teacher Don was able to elicit the first response from Daisy who claimed that algae are important and without them, there will be less fish, and this will lead to higher prices of seafood in the market. This was challenged by Ryan's counterargument who claimed that people can opt for other food options if prices of seafood will increase. Because of this, Daisy stated her rebuttal claiming that fish are important part of the dietary requirements for humans. Moreover, the argument was supported with the justification on the importance of fish as a food source as it is usually preferred by some people like the Muslims who are on dietary restrictions due to their religion.

Analysis showed that this simple linear argumentative map was produced because no further counterarguments and rebuttals were shared by the students. As such, they had no opportunities to use examples or apply their scientific knowledge to back-up their claims. Thus, this encouraged less participation and students were not able to express more of their argumentative agencies. Studies have shown that traditional teachers have the tendency to formulate dialogic statements with predetermined answers and thus wait for students' responses for immediate evaluative prompts. In this study, Teacher Don's dialogic scaffolding practice in the fading phase decentered the classroom learning environment from the usual IRE discussion pattern to a more social-constructivist learning process and the students expressed their argumentative agencies during their more open-ended and participatory discussions (Teo, 2016). Emphasizing on the students' expression of their argumentative agencies, teachers engaged the students in an open-space dialogue where they were allowed to challenge the ideas and opinions of their peers, teachers, and even their textbooks which resulted into greater negotiation of

knowledge construction instead of the usual knowledge acquisition solely from their teachers (Alexander, 2008)

***Willingness to take the responsibility to respond to personal and/or peer inquiry.*** Constructivist learning concerns the active involvement of students in the process of knowledge construction. As such, in argumentative learning, their claims are constantly being solicited for evidences that enhance their validity and acceptability. In a dialogic learning environment which is grounded on scientific argumentation, students' expressions of argumentative agency, particularly in the fading phase are constantly and dynamically being monitored for proper dialogic scaffolding. Most often, these were accomplished by the students themselves as they were already given full autonomy for their expressions of argumentative agency. It is however, important to note that, while students were momentarily given opportunities for intra-discursive expressions of their argumentative agency, the teacher must still be in full monitoring of their dialogic exchange so that when the need arises that their interaction demands scaffolding, the teacher can readily be responsive to support the chains of reasoning that is taking place.

In the dialogic exchange that happened in among the students of Teacher Mara, the momentary autonomy for discussion provided to them yielded productive dialogic exchange as they were responsible enough to take the roles of being dialogic scaffolds for each other during their discussions. Their teacher was responsive to acknowledge their willingness to participate in the discursive interactions which were developed from the contingency phase. Thus, as they progressed to the fading phase, the moment-by-moment participation of their teacher was supportive enough to guide their dialogic inquiry of scientific concepts. Through their critical dialogic roles, their questions to each other became grounds for analytical and reflective thinking about the interrelationships of the science concepts that were integrated in their current discussions.

Self-questioning thrives and become successful when students capacities are recognized. In dialogic inquiry, this can be developed from the contingency phase that lead to more desirable and dynamic exchange in the fading phase. Characterized by a collaborative and dynamic interaction where participants actively express their constructive and critical argumentative agency, dialogic inquiry draws on students' communication and decision-making skills when their discussion revolves around the social and cultural embeddedness of science to their daily lives.

The advantages of dialogic inquiry were implicated in the expressions of argumentative agency in this group of students. They were able to configure their learning of content when they were responsive to their teachers' provision of autonomy in discussion in the fading phase which encouraged them to question, propose, and challenge each other rather than simply assimilating facts (Eagle and Conant, 2002). The dialogic prompts "*Why do you think so, do you mean to say...*" produced interaction spaces to reflect, clarify, or expand their own ideas. Learner argumentative relationship changed as they began to develop a sociocultural perspective and use the opportunities to generate more productive dialogic prompts with their peers, and provide responses queries for collective and dynamic thinking.

In the content-based discussions among the Special Science-Regular Biology students, this display of argumentative agency can be observed in Transcript 15. For example, in the first 15 lines with 12 chains of responses, students took turns to answer each other's questions even without Teacher Mara' dialogic prompts. Along the way, they even addressed each other's names such as in Line 12 when Alvin directly addressed his challenging dialogue to Luis. As such, Luis definitely took the responsibility to elaborate on his previous responses. Moreover, this was also enhanced when Teacher Mara increased their perspectives at the end of this fading portion when she explicitly addressed her questions by

referring her question to Angelie (Line 22). Through this, students mirrored her practice which enhanced the students to be responsible and accountable for elaborated claims.

This was also observed in Transcript 16. With the two fading portions in this transcript, it was evident how students managed to take turns in expressing their argumentative agency to strengthen their claims with elaborated responses in the absence of their teacher's dialogic prompts or with unsolicited responses. As such, their autonomy in doing inter-argumentative discussions was developed in a negotiated dialogic exchange using conceptual term for their reasoned arguments. Moreover, in the second half of the fading portion in this transcript, Teacher Mara's dialogic scaffolding prompt in Line 14, "who can answer that?" was enough to elicit their expressions of argumentative agency as they tried to solve their problem about the X-lined pattern of inheritance. Mapping these content-based interactions would usually result to simple constructive argumentative maps. Despite a long chains of reasoned arguments that were uttered, their responses tend to support each other with expressions of constructive argumentative agency such as in Figure 12.

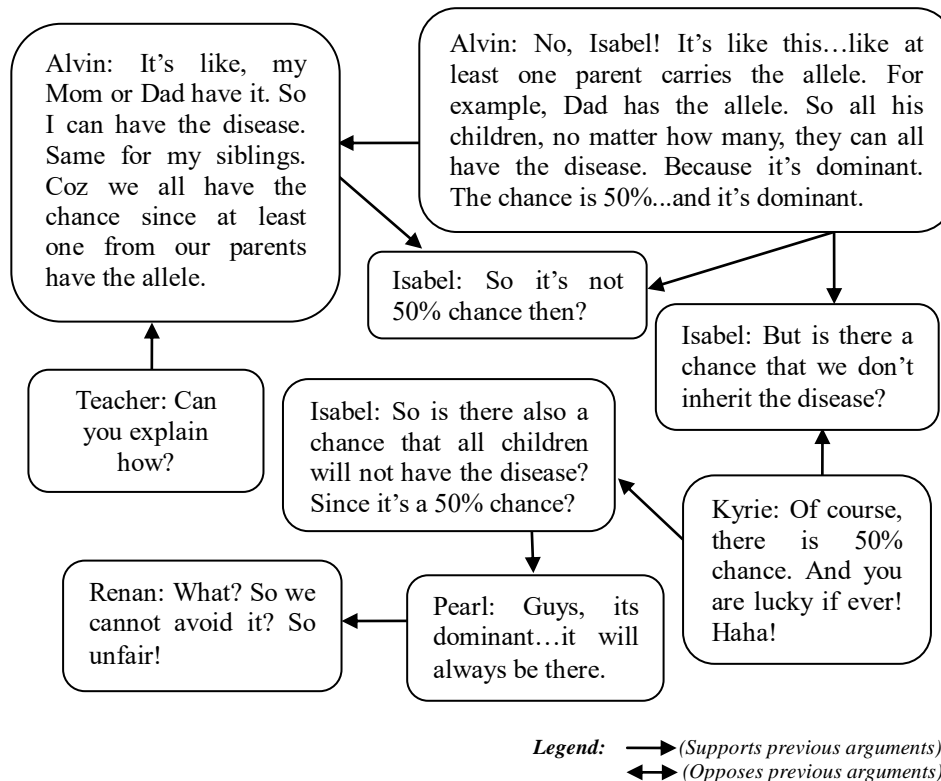


Figure 12. Simple constructive argumentative map in a content-based class with expressions of purely constructive argumentative agency.

In the argumentative map in Figure 12, the class was discussing about the probability for the inheritance of an autosomal disease. From the discussion, it can be observed that Teacher Mara prompted the students to present a summary of their discussion which led Alvin with a summarized response. However, Isabel's series of clarificatory dialogues prompted Alvin to supplement his justification by providing an example that would clarify his previous argument. As Isabel continued with more clarification questions about the topic, other students (Kyrie and Pearl) provided short responses from previous knowledge even without Teacher Mara's solicited prompts.

In this argumentative map, students' dialogic interactions were mostly constructive with supportive statements to each other's claims with conceptual evidences from previous knowledge. It is important to emphasize however, that though the expression of students' argumentative agencies were limited to the constructive type and lessons were content-based, Teacher Mara opted facilitating the discussion instead of lecturing which established the classroom argumentation as the students were made responsible for their own learning. Though the students expressed one or two types of argumentative agencies in their discussions, it did not limit them from participation to the discussions. As students supported previous arguments with evidences from previous knowledge, the discussion was sustained with more participation and increased the series of interactions and they became epistemic agents who scaffolded each other.

The simple constructive argumentative maps on the other hand were characterized by more than five students in a series of peer-to-peer interactions expressing constructive argumentative agencies. In the simple constructive, the teachers' contingent dialogic scaffoldings were sometimes observed as they tried to increase the expression of their students' argumentative agencies. Figure 7 shows a simple constructive argumentative map of the dialogic exchanges in Teacher Mara's class with at least five (5) students interacting with each other and each of them expressing a constructive argumentative agency to achieve a consensus in their knowledge construction and in their achievement of their lesson objectives.

In this study, enhanced students' interactions resulted from the teachers' dialogic prompts which created interaction space and gave direction for their thinking. Dialogic prompts produced interaction spaces to reflect, clarify, or expand students' ideas (*Why do you think so, do you mean to say...*), establish a collaborative thinking (*Can you add more?*), and negotiate differences in perspectives (*Do you agree/disagree? Why?*). Moreover, taking the complex multi-

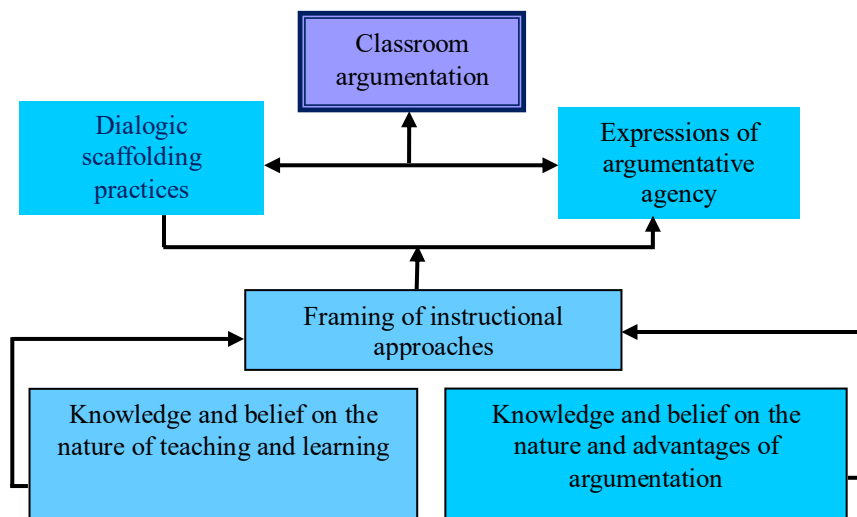
inferred argumentative maps, how students linked their current topic to other fields such as ethics, health, economy, and politics led to a wider range of discourse topics where they became open and were willing to use new evidences to revise their own thinking or supported the group's progress of shared thinking (van der Veen, van Kruistum, & Michaels, 2015). To establish the interplay of interactions, the dialogic utterances and expressed argumentative agency of the students especially in fading phases where the complex type of argumentative maps were found became more engaging as they responded not only to agree or support but to consider the "otherness" of opinions when they challenged, clarified, and evaluated previous statements



## **Chapter 6. Summary and Conclusion**

This study explored the teachers' dialogic scaffolding for their students' expressions of argumentative agency in classroom argumentation. It was guided by the rationale that harnessing the dynamic function of language to maximize the success of the Philippines' MTB-MLE basic education advocacy made classroom argumentation a possible inquiry-based approach to biology education making it a promising minds-on inquiry approach in response to the varying challenges of hands-on or laboratory-based practices in the Philippines. Language use can be focused on oral classroom argumentation to establish the dynamic interplay of teachers' dialogic scaffolding to elicit students' expressions of argumentative agency during their discursive inquiry.

Results showed that using a multiple case study analysis, the teachers had different dialogic scaffolding practices for classroom argumentation implementation. These differences however, were due to their varying levels of knowledge and beliefs on the nature of teaching and learning and on the nature and advantage of classroom argumentation (Figure 13). These beliefs eventually affected their framing of instructional approaches to implement classroom argumentation (SSI-based or content-based) which further influenced their dialogic scaffolding practices. Four themes, which were associated to their framing of instructional approaches, emerged as the teachers' dialogic scaffolding practices in the contingency phase namely: 1) appropriation strategies, 2) enactment of the culture of negotiation, 3) conceptual-reflective questioning, and 4) flexible affirmations of students' ideas for collective consensus. In the fading phase, two themes represented the teachers' dialogic scaffolding and similarly, these were aligned to their instructional approaches to classroom argumentation implementation.



*Figure 13.* Teacher factors which affected their framing of instructional approaches that eventually affected their dialogic scaffolding for students' expressions of argumentative agency.

In order to implement their personal dialogic scaffolding practices, each teacher employed two different but related dialogic scaffolding strategies to support the students' expressions of argumentative agency in the contingency phases. In the SSI-based class, using the appropriation strategies, Teacher Loida dialogically scaffolded the students by: 1) using prior scientific knowledge to build abstract concepts from simple ones, and 2) providing scenarios that may be experienced by the students. In the enactment of the culture of negotiation, Teacher Carlo used the strategies: 1) offering neutral points of view as prerequisites for integrative negotiation, and 2) converging disparate ideas leading to collective consensus. In the content-based classes, Teacher Don implemented his conceptual-reflective questioning by: 1) questioning using factual-canonical concepts, and 2) extending the discussion through reflective inquiry. Finally, using the flexible affirmations of students' for collective consensus, Teacher Mara implemented the flexible affirmations of students' ideas for collective consensus by: 1) providing reinforcement for a mutually contingent dialogic exercise, and 2) voicing to increase students' backing and enhance their discursive identity.

In the fading phase, two themes, each representing the SSI-based classes and content-based classes were identified: 1) recognition of students' knowledge capitals, and 2) sensitivity to students' willingness to participate in the dialogic exchange (Figure 14). In the SSI-based classes, Teacher Loida recontextualized her classroom dynamics while Teacher Carlo established the power distribution of discursive ideas. In the content-based classes, Teacher Don was responsive to and was willing to raise students' cognitive demands while Teacher Mara provided gradual students' autonomy for their uptake of the contingent dialogic prompts. It can be observed that there were more dialogic scaffolding practices that were observed in the contingency phase than on the fading phase. This can be attributed to the gradual withdrawal of the teachers from the discussions during the fading phases as they slowly provided the students with autonomy to maneuver their own discussions with unsolicited responses.

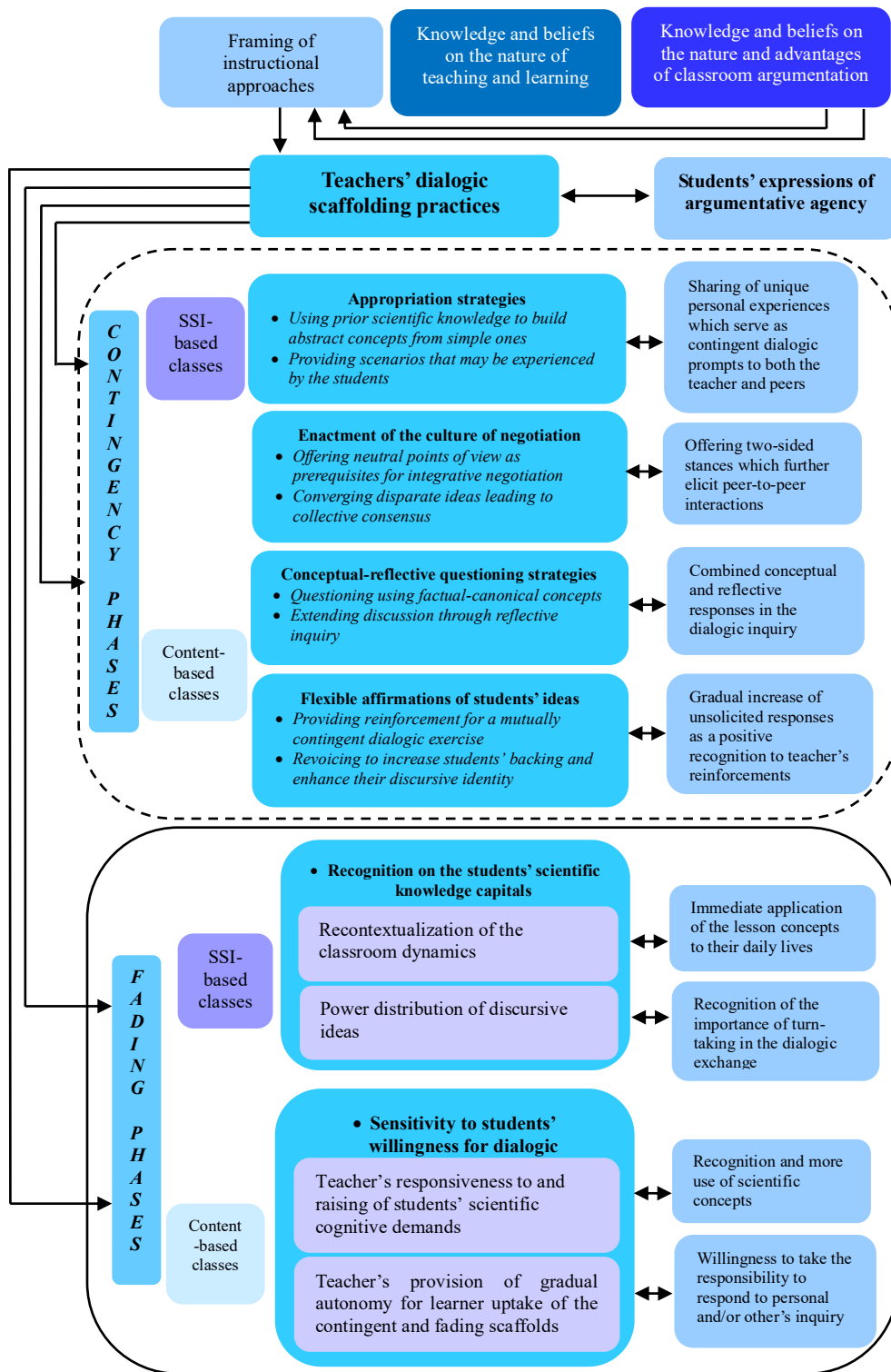


Figure 14. Teachers' dialogic scaffolding practices and strategies which elicited students' expressions of argumentative agency.

As shown in Figure 15, teachers' dialogic scaffolding prompts played important roles in the enactment of classroom argumentation. In this study, three types of dialogic scaffolding prompts were identified based on the analyses conducted on the classroom transcripts namely: conceptual, analytical, and reflective. In each of these types, varied dialogic prompts were expressed by the teachers to elicit responses which scaffolded their students towards varied expressions of their argumentative agency. The conceptual type of dialogue was composed of orienting to hint and exploring prerequisite knowledge. Orienting to hint was the teachers' dialogue which provided the students with background knowledge and notified them to relate their topic to prior scientific knowledge to strengthen their arguments, counterarguments, and rebuttals during their argumentative discussions. Exploring prerequisite knowledge on the other hand, was the dialogue that elicited clarifications from the students about their understanding of related terms used in the current lesson context and asked them to contextually define scientific terms.

Analytical dialogues were statements that slowly built the argumentative scenarios that were about to take place in the contingency phases so that their discussions would progress into the fading phases. These teachers' dialogues generated ideas and explanations and presented argumentative prompts. To generate ideas and explanations, the teacher tried to clarify from the students their evidences of their claims in their formulated arguments, counterarguments, and rebuttals. Moreover, the teachers tried to ask the students' explicit explanations for the scientific terms that they have presented in order to establish a common grounded knowledge. It is also in this type of dialogic scaffolding prompts when teachers began to present argumentative scenarios related to their topic to challenge students in sharing their personal judgments or decisions on the issues.

Finally, for the reflective dialogic prompts, the teachers tried to extend the discussions by probing further and enabling students to exercise their reflective

thinking. Probing further, the teachers asked for elaborations to students' arguments, counterarguments, and rebuttals. In situations where everyone supported certain arguments, the teachers probed further by playing a "devil's advocate" that elicited either counterarguments or rebuttals. Enabling reflective thinking was another way to extend the classroom argumentation by encouraging the students to connect their lesson towards real-life phenomena. Through this, students were able to readily identify the application of their lessons to tangible experiences that deepened the quality of their learning. As such, teachers usually formulated critical questions in order to invoke students' practice of decision making.

The teachers' dialogic prompts yielded varied students' dialogic roles as expressions of their argumentative agency in both the contingency and fading phases. In this study, the contingency phase was also termed as inter-thinking collective argumentation with the teacher's full participation in the dialogic exchange which slowly established the students' autonomy for their expressions of argumentative agency. The dialogic exchanges in the contingency phases gradually leveraged the discussions towards the fading phases. In the fading phases, the teacher tried to gradually withdraw participation from the discussions so that even without dialogic prompts, students autonomously served as argumentative agents for each other through their own dialogues (unsolicited responses). However, there were also instances when the teacher provided short and open-ended dialogic prompts that increased the perspectives of the students.

In both the contingency and fading phases, the teachers' dialogues played varied roles depending on how they tried to extend the students' expressions of their argumentative agency. In the contingency phase, the teachers' dialogues served as linking statements to students' prior knowledge, recapitulating or recapping the most important learning points from their dialogic statements, appropriating their contributions, recasting their wordings to match the ideas appropriate for discourse, cued eliciting in order to offer verbal or gestural hints

about expected responses, and increasing dialogic perspectives in order to give them the responsibility to continue the discussion.

Similarly, in the fading phases, the teachers' dialogues served as supports to students' arguments, counterarguments, or rebuttals by adding information or acknowledging the science behind their statements to sustain the exchange of ideas. Moreover, their dialogues became tools for communication to exist as they invited more dialogic interactions. Thus, they were useful in eliciting elaborated responses from the students as they identified the applications of the science concepts to other fields of study. Finally, the teachers' dialogues served as prompts to extend the students' capacities by transferring them the responsibility to answer questions that were raised by others.

As a response to these dialogic prompts, students dialogues in both the contingency and fading phases played two types of roles in their expressions of their argumentative agency: constructive and critic. Constructive role is composed of supportive and reasoning out dialogues during their peer-to-peer interactions. In their supportive roles, students built and strengthened each other's arguments by backing up, modifying, or adding scientific concepts in order to increase the validity of their evidences and justifications on their claims. When they reasoned out, students tried to defend the previously presented claims, supplement the evidences, or present rebuttal statements. Critic role is composed of students' challenging, clarifying, and evaluative dialogues during their discursive exchanges with their peers. Students' dialogues played the roles of challengers or clarifiers when they tried to question each other with reference to a data presented to them or to their existing knowledge as a product of their research or to elicit the meaning of the ideas that were previously presented. They became evaluators when they began to question the strengths or weaknesses of others' arguments, counterarguments, or rebuttals as they tried to elicit further evidences and justifications to claims.

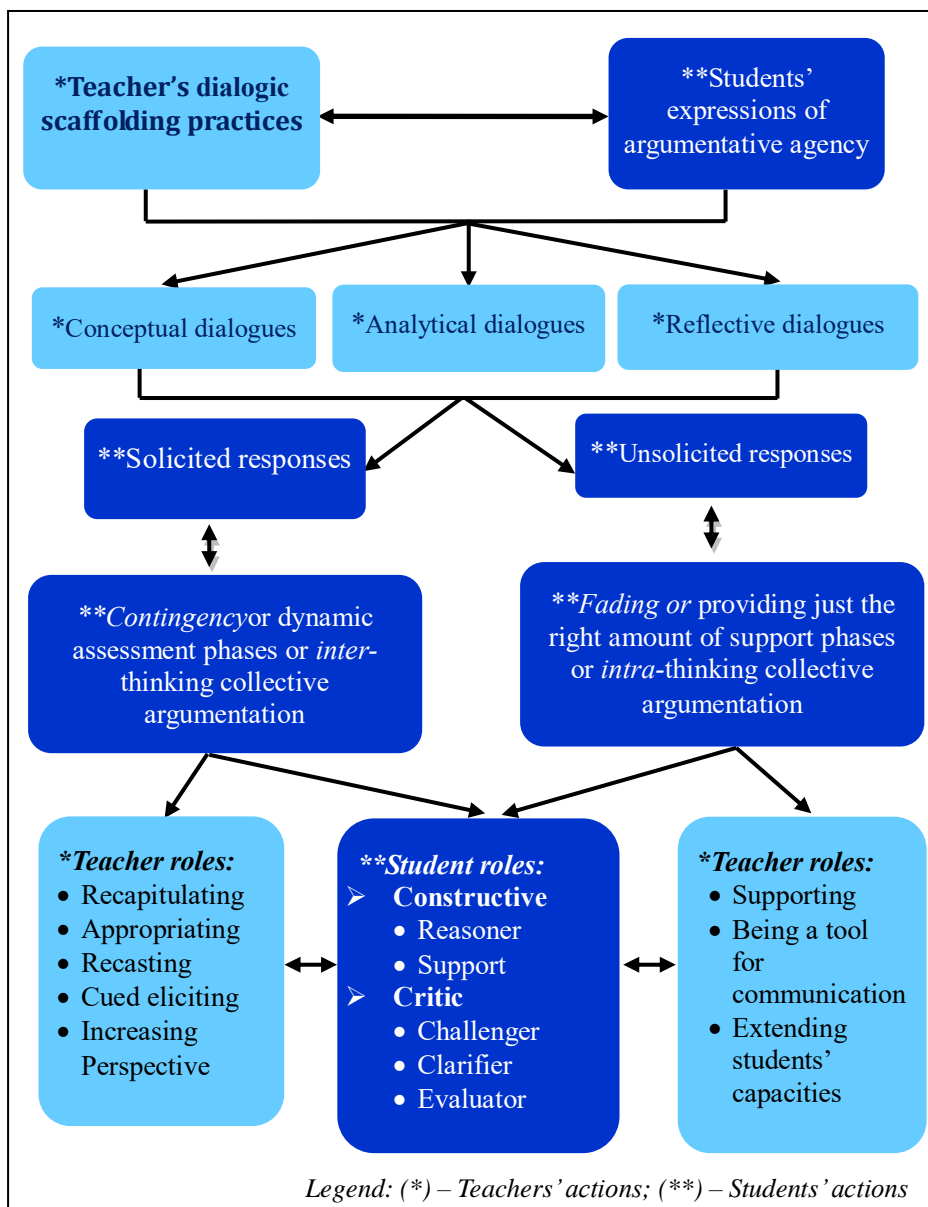


Figure 15. Teachers' dialogic prompts which scaffolded the students' constructive and critic responses during expressions argumentative agency in both the contingency and fading phases.

Dialogic learning environment involves two parties interacting with each other. In a learning environment such as the classroom, teacher-students and student-student interactions were obviously taking place. Thus, in response to the teachers' dialogic scaffolding practices, students' expressed their argumentative



agency in alignment to their teachers' dialogic scaffolding strategies. In this study, two themes emerged as the expressions of the students' argumentative agency, each of these corresponded to the phases of their dialogically-scaffolded interactions: 1) neutral and immediate application of scientific knowledge in the dialogic responses in the contingency phase, and 2) use of science concepts, willingness to take part, and recognition the advantages of turn-taking in the fading phases.

In the contingency phase of the SSI-based classes, students in Teacher Loida's class shared their personal experiences which served as contingent dialogic prompts to her and their peers. On the other hand, Teacher Carlo's students provided two-sided responses which further elicited peer-to-peer interactions. In the content-based classes, Teacher Don's students responded with combined conceptual and reflective responses in the dialogic inquiry while in Teacher Mara's class, students positively recognized the reinforcements through gradual increase of unsolicited responses.

Because of the varied roles expressed by the students in their expressions of their argumentative agency, different argumentative maps were constructed which displayed the patterns and trajectories of their dialogic utterances (Figure 16). These maps were researcher-made from the iterative analysis of the classroom transcripts. Moreover, these maps determined the flow of their dialogic interactions. Most importantly, these maps were classified according to the nature of the chains of responses (conceptual or inferential) that were shared in the argumentative discussions as expressions of students' argumentative agency. Two types of argumentative maps: simple and complex were constructed from the patterns and trajectories of their dialogic statements as they expressed their argumentative agency in response to their teachers' dialogic prompts.

Simple argumentative map has two types: simple linear and simple constructive and were characterized by the length of the chains of responses when

students expressed their constructive argumentative agency by either supporting previous responses or reasoning out with valid evidences in support of previous claims or arguments. Thus, counterargument and rebuttal statements were not usually observed in the chains of responses in the simple argumentative maps. Simple linear maps were characterized by a maximum of five chains of responses which contained mostly constructive types of students' dialogues. However, there were times when a simple linear map was produced in the chain of five responses with at least one critic type of argumentative dialogue. When the critique types of dialogic roles were usually followed by support or reasoning out, the discussion shifted the chains of responses back to conceptual discussions. Simple linear maps were mostly constructed from the dialogic interactions in the contingency phases in both the SSI-based and content-based classes.

Simple constructive argumentative maps were mostly constructed from the fading phases where constructive types of students' dialogues were observed as expressions of their argumentative agency. In this map, at least seven chains of responses were present which extended the discussions that were focused on constructive support or adding reasons to previously expressed dialogic statements. These were also constructed from the SSI-based classes particularly in the early parts of their discussions when the discursive inquiries were centered on the factual-canonical knowledge as prerequisites to the socioscientific issues.

The complex conceptual argumentative maps were constructed from the content-based classes where students expressed their content knowledge and argumentative agency using their constructive dialogues. These maps were observed in both the contingency and fading phases when the discussions were centered on the building up of background conceptual knowledge which served as conceptual evidences for the succeeding arguments. Moreover, the chains of arguments were mostly from science content knowledge from various topics. In the contingency phases, students' dialogic scaffolding prompts were evident in the

form or short and provocative prompts which prolonged their interactions. In the fading phases, the chains of responses were purely student-centered as an evidence of their full autonomy.

The complex multi-inferenced argumentative map was different from the complex conceptual in that the chains of responses were composed of students' inferences and opinions when they expressed their argumentative agency with both constructive and critic dialogic roles. These maps were mostly found in the SSI-based classes where students had the opportunity to express their argumentative agency using claims and evidences from the applications of biology concepts to various fields such as ethics, politics, economy, health, social welfare, and equality. At times that these were observed from the content-based classes, it was observed that their discussions were products of the students' responses to the teachers' reflective dialogic prompts which elicited their competencies to identify the connections of their science topics to practical knowledge.

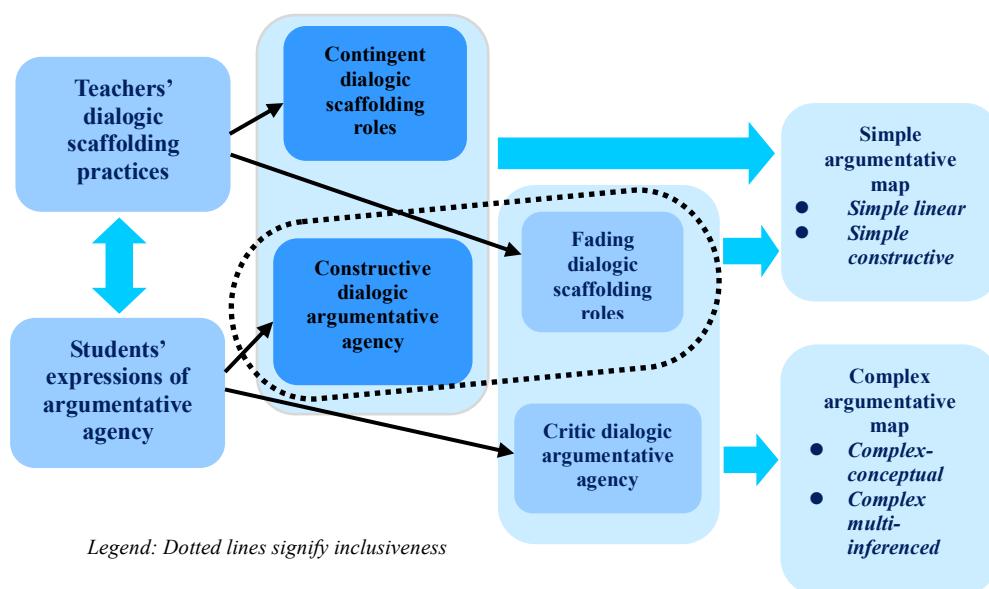


Figure 16. Effects of the teachers' dialogic scaffolding on the patterns and trajectories of students' utterances during their expressions of argumentative agency.

Based on the results of this study, the various dialogic scaffolding practices of the teachers support Alexander's (2008) recommendation of dialogic teaching wherein classroom interaction must avoid the recitation method so that students are provided with enough opportunities to listen, question, and critique their viewpoints. These also support previous claims that based on the teacher's provision and promotion of appropriate dialogues which empowered their students to think and learn (Alexander, 2008), students' "success at school may be more of a function of the quality of dialogue with their teacher and the opportunities they created for 'interthinking' rather than a function of their ability or the teacher's skill" (Sewell, 2011, p. 271).

According to Teo (2016), classroom learning is a combination of instruction and dialogue. This was observed in the four cases of this study as dialogue was used as a mode of instruction and to scaffold the increase of interactivity and dynamic exchange of ideas. While the teachers allowed the spontaneous flow of ideas beyond pre-determined responses by not providing immediate evaluative prompts, they were able to initiate and steer the direction of discussion towards consensus. More than conceptual and factual knowledge, teachers' dialogic scaffolding for argumentation is a promising method for the gradual enhancement of students' communication skills and honing of their reasoning skills as they were provided with a learning environment where they were allowed to fully express their argumentative agency such as supporting reasons, clarifying arguments and counterarguments, evaluating claims and evidences, and providing reasons as initial responses to dialogic prompts.

## Chapter 8. Implications and Recommendations

Through this study, it has been shown that argumentation can be a possible minds-on inquiry-based approach in biology education and this can be implemented through various teachers' dialogic scaffolding practices. Thus, in the Philippine science education system whose current problem is the implementation of inquiry-based approaches in alignment to national and international standards, the various dialogic scaffolding practices in classroom argumentation which were found out in this study can be utilized. The findings support research-based efforts to finding out and developing strategies of promoting classroom argumentation to the teaching and learning of science. Moreover, results showed that inquiry-based learning can be successful if teachers deliberately frame their instructional approaches towards classroom argumentation. Given that the teachers are willing to dialogically scaffold their students, focusing on the 'argumentative talk' which is primarily applied in the dialogic inquiry would lead to students' expressions of argumentative agency comes out naturally as normal responses to teachers' dialogic prompts.

Results of the study also imply that the framing of instructional approaches of teachers on classroom argumentation was dependent on their knowledge and beliefs on the nature of teaching and learning and on classroom argumentation. This means that in both pre-service and in-service education, teachers' knowledge and beliefs systems should constantly be updated or enhanced. This is because, if they ask their students to express their argumentative agency, they themselves should also possess argumentative agency much more that they are mentors in the class who are expected to dialogically scaffold the implementation of classroom argumentation. Moreover, as previous studies explicated that teachers' knowledge does not guarantee their implementation, their constructivist views and their beliefs on classroom argumentation should be boosted in their pre-service years through various methods such as trainings, personal involvement for

the development of learning materials, and direct practice to enhance their pedagogies. The study therefore recommends teacher educators to increase pre-service teachers' exposures on inquiry approaches to science education such as argumentation. Results of the study can thus be used as basis to construct professional development models that would develop the dialogic scaffolding practices of teachers.

Results corroborate previous findings in which the authoritarian or monologic teaching is just a manifestation of lack of confidence and insecurity among teachers to implement classroom argumentation with the notion that it demands their strong foundation of science content to challenge and stretch the capacities of their students to grasp the meaning of the subject matter. It is therefore recommended that as both pre- and in-service teachers set aside their traditional views of knowledge construction, their content knowledge should be equally improved so that they are able to maneuver and explore their topics for discussion without neglect of the required students' competencies and without fear of facing students' queries in the dialogic exchanges.

Focusing on the case of the Philippines, as teaching loads were restructured in response to the recent modification in the curriculum, trainings should not only be focused on pedagogical development but also on content knowledge to increase their confidence in exploring their lessons. Much as this is a pressing issue for the in-service teachers, collaborative professional development with experienced teachers can be a preliminary move in every school so that inexperienced teachers would be exposed to the effective implementations of the prescribed learning materials by the experienced teachers. Collaborative activities may include slight modifications of the learning materials where inexperienced teachers can be actively involved in deciding which areas needed alignment to the argumentation for students' maximum expressions of argumentative agency. This would lead to the establishment of a community of learning practice where all

teachers develop accountability in their learning process which may lead to willingness to take actions for the try-out and development of reform-based learning materials.

Based on the results, the study recommends that future research may explore possible professional development models that would help the teachers in developing their classrooms as epistemic and dialogic sites for classroom argumentation. PD models can focus on how to develop collaboration with experienced and knowledgeable teachers such as Teachers Loida and Carlo in this study with novice teachers.

Considering the phases of scaffolding, the study recommends the conduct of longitudinal studies that will focus on the three phases namely: contingency, fading, and transfer of responsibility. This can be done by classroom argumentation researchers in collaboration with teachers who are willing to implement classroom argumentation through dialogic scaffolding.

As the study was concerned with whole class discussions, future studies can also be done to focus on groups of students or paired students. Studies can be focused on the depth of their reasoning when their ideas were formed in collaboration with peers. In the analysis of roles, results of these studies would add to the identified dialogic roles in this study as expressions of their argumentative agency. Moreover, responses can also be explored in terms on how they are able to relate their current topics to other scientific or practical knowledge. This is especially significant when studies are concerned with the conceptual formation among the students.

Comparative analyses can also be explored on the various topics in biology. For instance, future research can focus attention on how students would express their argumentative agency on topics such as evolution, biodiversity, basic anatomy and physiology. In these studies, responses can be traced on how students

express their argumentative agency on topics which are purely conceptual and topics which are issue-based.

Other areas in high school science such as physics, chemistry, and earth science and the basic science classes in the elementary school can also be focused in future studies. Especially in studies in physics and chemistry, argumentative agencies can be focused on the problem-solving skills of students. Coding of their arguments can be focused on the quality of their reasoned arguments on how they were able to solve problems in varied ways. Finally, in the language education, the study recommends the exploration of students' expressions of argumentative agency on how to understand meanings of words based on their responses. Future studies on this can focus on how students derive meaning of words through their dialogic exchange.



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## 국문초록

본 연구에서는 과학 수업에서 나타나는 교사의 대화적 스캐폴딩 실행과 전략을 주제별로 탐색하였다. 대화적 탐구는 교사와 학생 사이의 상호작용을 요구하고 있어서, 교사의 대화적 스캐폴딩에 대해 학생들이 보이는 논변적 행위주체성을 탐색하는 것이 필요하다. 본 연구는 조작에 초점을 둔 탐구활동 및 실험활동 수행이 어려운 필리핀 생물 수업에서 인지에 초점을 둔 탐구 교수/학습 방법으로 논변활동을 활용할 가능성을 탐색하는데 그 목적을 두고 있다.

본 연구에서는 필리핀의 과학 교사 4명과 그들이 가르치는 학생들을 참여자로 하여 질적 사례 연구가 수행되었다. 총 20차시의 수업에 대한 녹화, 녹음 전사본을 주된 자료로 사용하였으며, 반복적 비교분석법을 사용하여 담화에서 드러나는 교사의 대화적 스캐폴딩과 학생들의 논변적 행위주체성을 찾았다. 또한 질적 자료들의 타당성을 확보하기 위해 설문조사, 공식 및 비공식 면담, 비참여 관찰 자료를 추가적으로 사용하였으며, 이러한 자료를 활용하여 교수/학습의 본성, 교실 논변활동의 본성과 장점에 대한 교사들의 지식과 신념을 이해할 수 있었다.

근거이론의 반복적 비교분석법을 통하여 우발적 지원 단계(contingency phase)와 지원 소멸 단계(fading phase)에서 나타나는 교사의 대화적 스캐폴딩 실행 및 학생들의 논변적 행위주체성을 찾아내어 범주화하였다. 4개 반에서 각각 5차시씩 총 20차시의 수업을 분석하여 우발적 지원 단계로부터 지원 소멸 단계로 이행하는 논의과정을 찾고, 여기서 드러나는 교사와 학생 간의 대화적 상호작용을 대주제와 소주제로 범주화하였다. 선행연구에서 제시된 분석틀 활용 방법과 데이터로부터 귀납적으로 찾아내는 방법을 혼합·적용하여 각

주제들을 도출하였다. 코드체계는 교사와 학생의 대화적 상호작용을 이해하기 위해 만들어진 것으로, 대화의 유형 분석과 대화에서 나타나는 역할 분석에 초점을 두었다.

대화적 스캐폴딩은 학생들의 행위주체성 발현을 위해 교사가 담화적 지원으로 제공한 것이다. 학생들은 우발적 지원 단계에서는 요청된 반응을 주로 하면서 대화적 탐구에 참여하고자 한 데 비해, 지원 소멸 단계에서는 요청받지 않은 반응을 하면서 대화적 탐구에 참여하였다. 본 연구는 교사와 학생들의 대화적 상호작용에 초점을 두고 있어서, 두 단계에서 나타나는 교사의 대화적 스캐폴딩 프롬프트와 학생들의 반응이 모두 기록되었다. 교사의 대화적 스캐폴딩 프롬프트는 ‘개념적’, ‘분석적’, ‘반성적’으로 범주화되었고, 이들은 각 단계별로 다른 역할을 한다고 드러났다. 교사의 스캐폴딩은 우발적 지원 단계에서는 사전 지식 연계 요구, 내용의 재요약 요구, 수업 담화에 기여 요구, 진술의 재구성 요구, 예상된 반응을 위한 힌트 제공, 학생들의 지속적인 토론 참가를 위한 책임감 부여 등의 역할을 한 데 비하여, 지원 소멸 단계에서는 토론 지속을 위한 지원, 토론 확장을 위한 프롬프트 제공, 학생들의 역량 확장 기회 제공 등의 역할을 하였다. 대화적 상호작용에서 학생들이 드러낸 논변적 행위주체성은 두 단계에서 모두 긍정적 역할을 하였다. 자신의 주장 제공과 지지를 위한 추론을 하였으며, 기존 주장에 대한 명료화, 이에 대한 반박과 평가 과정에서 비판적 사고를 드러냈다.

연구 결과에서 4명의 교사는 논변활동 지원을 위해 서로 다른 대화적 스캐폴딩 실행을 보인 것으로 나타났는데, 이러한 차이는 교사들의 교수/학습에 대한 지식과 신념, 논변활동의 본성과 장점에

대한 지식과 신념이 다양한 수준을 보인다는 것과 관련이 있다. 이러한 신념들은 논변활동의 교수적 접근(SSI 기반 또는 내용 기반)에 대한 프레이밍에 영향을 미쳤고, 더 나아가 그들의 대화적 스캐폴딩 실행과 전략에 영향을 주었다. 교사가 우발적 지원 단계에서 교수적 접근에 대한 프레이밍과 관련하여 제시한 대화적 스캐폴딩 실행은 ‘적절한 인식적 실행을 위한 전략 구사하기’, ‘협상 문화 구축하기’, ‘개념적-반성적 질문하기’, ‘공동의 합의를 위해 학생들의 아이디어에 유연한 자세 가지기’로 나타났다. 지원 소멸 단계에서는 ‘학생들의 지식 자원 인식하기’, ‘학생의 대화적 상호작용 참여 의지에 민감하기’ 등의 스캐폴딩을 보였다.

각 교사는 우발적 지원 단계에서 학생들의 논변적 행위주체성 지원을 위해 두 가지의 서로 다르지만 연관된 대화적 스캐폴딩 전략을 사용하였다. 교사 Loida는 SSI 기반 수업에서 ‘적절한 인식적 실행을 위한 전략’을 구사함으로써 1) 학생들로 하여금 사전 과학 지식을 사용하여 단순한 개념으로부터 추상적인 개념을 구성하도록 하였고, 2) 그들이 실제로 경험했음직한 시나리오를 제공하였다. 교사 Carlo는 ‘협상 문화 구축’을 위해 1) 독립적 관점을 제공함으로써 통합 방향의 협상이 이루어지도록 하였고, 2) 이질적 아이디어를 수렴시켜 공동의 합의를 이끌어내었다. 교사 Don은 내용 기반 수업에서 1) 사실적인 정규 개념을 이용한 질문하기, 2) 반성적 탐구를 통한 논의 확장하기를 실행함으로써 ‘개념적-반성적 질문’의 스캐폴딩을 드러냈다. 마지막으로, ‘공동의 합의를 위해 학생들의 아이디어에 유연한 자세 가지기’를 보인 교사 Maria는 1) 대화적 실행에서 우발적 지원을 강화하였고, 2) 학생들의 지지 증가와 이들의 담화적 정체성 증진을 조율하였다.



분석 결과는 필리핀의 과학 수업에서 논변활동을 통해 인지에 초점을 둔 탐구학습이 가능함을 보여준다. 조작에 초점을 둔 탐구활동 및 실험 기반 탐구 활동 수행이 제한적인 필리핀 교실 환경에서 탐구 기반 교육의 긍정적인 대안을 제공한 연구라 하겠다. 교사의 대화적 스캐폴딩 실행이 그들의 교수/학습의 본성, 교실 논변활동의 본성과 장점에 대한 다양한 수준의 지식/신념과 관련되었다는 결과로 볼 때, 예비 교사와 현직 교사들의 구성주의적 신념을 계발시킬 수 있는 교사 전문성 향상(PD) 프로그램이 요구된다. 이러한 프로그램은 교사들로 하여금 탐구 기반 교수에 대한 프레이밍을 갖도록 하고 대화적 스캐폴딩을 통하여 논변활동과 같은 탐구 기반 교수 실행을 할 수 있도록 도울 것이다. 또한, 이러한 교사 전문성 향상 프로그램이 모국어 기반 다언어 교육(MTB-MLE) 프로그램의 성공과 함께 논변활동 촉진을 위한 언어 사용 극대화에 그 목적을 두는데 대해 함의를 제공하고, 추가적인 후속 연구를 제안하였다.

# APPENDICES

## I. Communications

15 January 2018

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Dear \_\_\_\_\_,

Greetings!

I am Sally B. Gutierrez, a doctoral student under the Biology Teaching and Learning Laboratory at the Department of Science Education, College of Education, Seoul National University, South Korea.

I am writing to ask your permission for me to conduct a classroom observation and assessment of one biology class in your school which will serve as my dissertation data. My dissertation is titled "Teachers' beliefs on science teaching-learning: Effects on their dialogic scaffolding for enhanced students' argumentation and NOS views." The following is a short synopsis of the research.

**Purpose:** The research seeks to understand the teachers' beliefs in science teaching and learning and its impact on their dialogic scaffolding of students' argumentation and their beliefs on the nature of science.

**Procedure:** The researcher will be observing the classroom 5-10 times from January 12-February 11, 2018 using observation sheets and two cameras to capture a video coverage of the classroom scenario. Within the observation time, the researcher will also ask the whole class to answer an assessment form to measure the argumentative skills and their nature of science beliefs. Teachers will also be asked to answer a short survey instrument in a Likert format and a written interview. Prior to the start of the observation, consent forms will be secured to ensure voluntary participation of both the teacher and the students.

**Potential risks:** This study involves no risk, no detriment to classroom work, and no adverse effect on achievement scores. Teachers and students will not be identified during data analysis and confidentiality will be highly ensured.

**Participation and withdrawal:** Participating in this research is entirely voluntary. Participants can withdraw at any time without consequences of any kind.

Your favorable approval on this request will be highly appreciated.

Sincerely

**Sally B. Gutierrez**  
Ph.D. Student, Seoul National University

Noted:

**Heui-Baik Kim, Ph.D.**  
Academic Adviser  
Biology Education, Seoul National University

## II. IRB Approval Sheets

IRB No. 1804/002-003

유효기간: 2019년 4월 8일

### SEOUL NATIONAL UNIVERSITY Consent to Take Part in a Research Study (Teachers)

1. **Subject Name:** \_\_\_\_\_
  1. **Title of Research:** Teachers' beliefs on science teaching-learning: Effects on their dialogic scaffolding for enhanced students' argumentation and NOS views
  2. **Investigator's Name:** Sally B. Gutierrez (Principal Investigator)
  3. **Research Entity:** Seoul National University
- This consent form may contain some information which is difficult to understand. If there is any information unclear, please contact and ask Sally B. Gutierrez. The contact numbers are written in the end of this consent form.**
4. **Why are we conducting this research?**  
The goal of the research is to gain understanding on the effects of science teachers' beliefs on the science teaching and learning affect their dialogic scaffolding practices for argumentative classroom and the development of students' argumentative skills and views on the nature of science in the Philippines. I will explain about our research before asking you to participate.
  5. **Why am I asked to participate in this study?**  
You and your students are being asked to participate in this study voluntarily. However, your signed consent form for you to participate.
  6. **Do I have to participate?**  
You may choose not to participate. There will be nothing harmful for choosing not to participate.
  7. **What am I going to be doing in this study?**  
If you agree to participate, you will be participating in following procedures.
    - 1) During about four (4) weeks, researcher will observe, video and audio record 12 science classes. The researcher will use an observation guide to record the dialogic scaffolding techniques you will be using in class and the argumentation responses of a group of 10 students in your class who voluntarily participated to join the group.
    - 2) In anytime during the observation period of the classes, the researcher will ask you to answer a nine-item (9 items) survey questionnaire in a Likert form and a written interview guide. You may choose not to write your name in the survey and interview guide. However, if you will write your name, it will be anonymized properly during data analysis.



8. **How long will this research take place?**  
The research is planned to take about four (4) weeks. During this period, you may be participating in 12 observations and to answer a nine-item (9 items) survey questionnaire in a Likert form and a written interview guide.
9. **Are there any side effects?**  
There are no potentially harmful risks related to participating in this study.
10. **Are there any disadvantages if I choose not to participate?**  
If you feel uncomfortable with participating in the study, you may not choose to participate. There are no disadvantages for choosing not to participate. If in case that you joined the group which was video-recorded, you will have to sign an agreement form together with the researcher that your involvement in the group will not be transcribed and thus it will not be included in the data analysis. If in case that you already answered the assessment form before you want to withdraw from participation, the researcher will retrieve your assessment form and will be marked so that it will not be included in the data analysis.
11. **Will I receive any present for participation in this study?**  
You will NOT receive any payment or any gift item for your participation in this study. You may not be directly benefited in this study however, your participation may help the researcher in analyzing the status of science education in the Philippines particularly on the stated research interest of this study. On request, you may be informed of the results of the study.
12. **If I have questions about the study, whom should I contact?**  
If you have any questions or anything unclear, please contact Sally B. Gutierrez (Korea Day Phone: \_\_\_\_\_ ; Philippine: \_\_\_\_\_ for further explanation. You may also contact the Seoul National University Institutional Review Board at 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Korea with the following numbers: phone \_\_\_\_\_ ; fax: \_\_\_\_\_

You will receive a copy of the signed consent form for your records. Your signature in the consent form is needed for your participation in this study.



*Informed consent is required for your participation. In the spaces provided below, please indicate your willingness to participate by placing your signature.*

1. I have read the consent form, and all my questions were answered by the researcher thus, I voluntarily consent my participation in the study.
  2. By participating in this study, I give permission that I will be observed by the researcher through an observation sheet and a video camera for 12 times within a month. Moreover, anytime during the observation period, I will be asked to answer a nine-item (9 items) survey form and a written interview guide.
  3. In the event that I want to withdraw my participation in the study anytime during the data gathering procedure, I may choose to allow the Principal Investigator to use the data collected from me thus far or agree to sign an agreement form with the Principal Investigator and my parents that all my data will be retrieved and disposed properly. However, I cannot withdraw my participation once all data were already analyzed.
  4. I agree to give the researcher limited information about me such as my age and number of years in teaching biology as a supplemental data for analysis only.
  5. I understand that I will NOT be paid nor be given any present for my participation. I may withdraw and discontinue participation at any time without penalty. If I decline to participate or withdraw from the study, no one on my campus will be told.
  6. I agree that only the Principal Investigator will have access to all forms of first-hand data and that transcripts from my classroom recordings will only be used for academic purposes primarily as dissertation data and conference presentations and journal article publication in the future.
  7. I agree that all first-hand data such as audio and video recordings and paper data such as observation guides, interview guides, and field notes will be securely stored within five (5) years after completion of the research.
  8. I agree that all consent forms will be kept within three (3) years after the completion of the research.
  9. I agree that five (5) years after the completion of the research, only coded data will be available for academic purposes by the Principal Investigator.
- Teacher's statement of consent: I have read the above information, have received answers to any of my questions. Therefore, I consent to take part in the study.

\_\_\_\_\_  
Name of teacher

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

- Legal representative's statement of consent: I have read the contents of this consent form. I understand that the teacher's consent does not take away any legal rights in case of negligence on the part of the researcher or any legal fault of anyone who is involved in this study. I further understand that nothing in this consent form is intended to replace any applicable federal, state, or local laws.

\_\_\_\_\_  
Name of legal representative

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Name of  
Primary Investigator

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date



SEOUL NATIONAL UNIVERSITY  
**Consent to Take Part in a Research Study**  
**(Students)**

1. **Subject Name:** \_\_\_\_\_
  1. **Title of Research:** Teachers' beliefs on science teaching-learning; Effects on their dialogic scaffolding for enhanced students' argumentation and NOS views
  2. **Investigator's Name:** Sally B. Gutierrez (Principal Investigator)
  3. **Research Entity:** Seoul National University
- This consent form may contain some information which is difficult to understand. If there is any information unclear, please contact and ask Sally B. Gutierrez. The contact numbers are written in the end of this consent form.**
4. **Why are we conducting this research?**  
 The goal of the research is to gain understanding on the effects of science teachers' beliefs on the science teaching and learning affect their dialogic scaffolding practices for argumentative classroom and the development of students' argumentative skills and views on the nature of science in the Philippines. I will explain about our research before asking you to participate.
  5. **Why am I asked to participate in this study?**  
 You, your teacher and your classmates are being asked to participate in this study voluntarily. However, your signed consent form and your parents' consent is necessary for you to participate. The whole class including you will be voluntarily participating in this research with your proper consent.
  6. **Do I have to participate?**  
 You may choose not to participate. There will be nothing harmful for choosing not to participate.
  7. **What am I going to be doing in this study?**  
 If you agree to participate, you will be participating in following procedures.
    - 1) During about four (4) weeks, the researcher will observe, video and audio record 12 science classes. The researcher will use an observation guide to record the dialogic scaffolding techniques of your teacher and your argumentation responses in class of a group of 10 students in your class. You may choose to participate in a group of 10 students who will be video-recorded during your science class. You may voluntarily participate in this group with your consent and your parents' consent. If not, your participation will just be limited to your answering of the assessment form.
    - 2) In anytime during the observation period of the classes, the researcher will ask you to answer an assessment form consisting of three (3) questions with a range of 5-8 sub-



questions each. You may choose not to write your name in the assessment form that will be administered anytime during the observation period. If in case that you will write your name, it will be anonymized during the data analysis.

8. **How long will this research take place?**  
The research is planned to take about four (4) weeks. During this period, you may be participating in 12 observations and to answer an assessment form consisting of three (3) items with a range of 5-8 sub-questions each.
9. **Are there any side effects?**  
There are no potentially harmful risks related to participating in this study.
10. **Are there any disadvantages if I choose not to participate?**  
If you feel uncomfortable with participating in the study, you may not choose to participate. There are no disadvantages for choosing not to participate. If in case that you joined the group which was video-recorded, you will have to sign an agreement form together with the researcher that your involvement in the group will not be transcribed and thus it will not be included in the data analysis. If in case that you already answered the assessment form before you want to withdraw from participation, the researcher will retrieve your assessment form and will be marked so that it will not be included in the data analysis.
11. **Will I receive any present for participation in this study?**  
You will NOT receive any payment or any gift item for your participation in this study. You may not be directly benefited in this study however, your participation may help the researcher in analyzing the status of science education in the Philippines particularly on the stated research interest of this study. On request, you may be informed of the results of the study.
12. **If I have questions about the study, whom should I contact?**  
If you have any questions or anything unclear, please contact Sally B. Gutierrez (Korea Day Phone: \_\_\_\_\_; Philippine: \_\_\_\_\_) or ask your parents for more explanation. You may read the Informational Letter for Parents for your understanding. You may also contact the Seoul National University Institutional Review Board (SNUIRB) at 1 Gwanak-ro, Gwanak-gu, Seoul 08826, Korea with the following numbers: phone \_\_\_\_\_ or + \_\_\_\_\_ fax: \_\_\_\_\_ through email: \_\_\_\_\_

You will receive a copy of the signed consent form for your records. You and your parents' signatures are needed for your participation in this study.



*Informed consent is required for your participation. In the spaces provided below, please indicate your willingness to participate by placing your signature.*

1. I have read the consent form, and all my questions were answered by the researcher thus, I voluntarily consent my participation in the study.
  2. By participating in this study, I give permission that I will be observed by the researcher through an observation sheet and a video camera for 12 classes within a month. Moreover, anytime during the observation period, I will be asked to answer an assessment form.
  3. In the event that I want to withdraw my participation in the study anytime during the data gathering procedure, I may choose to allow the Principal Investigator to use the data collected from me thus far or agree to sign an agreement form with the Principal Investigator and my legal representative that all data from me will be retrieved and disposed properly. However, I cannot withdraw my participation once all data were already analyzed.
  4. I understand that I will NOT be paid nor be given any present for my participation. I may withdraw and discontinue participation at any time without penalty. If I decline to participate or withdraw from the study, no one on my campus will be told.
  5. I agree that only the Principal Investigator will have access to all forms of first-hand data and that transcripts from my classroom recordings will only be used for academic purposes primarily as dissertation data and conference presentations and journal article publication in the future.
  6. I agree that all first-hand data such as audio and video recordings and paper data such as observation guides, interview guides, and field notes will be securely stored within five (5) years after completion of the research.
  7. I agree that all consent forms will be kept within three (3) years after the completion of the research.
  8. I agree that five (5) years after the completion of the research, only coded data will be available for academic purposes by the Principal Investigator.
- Student's statement of consent: I have read the above information, have received answers to any of my questions. Therefore, I consent to take part in the study. In addition to taking part in the study, I also consent to (please check below):
    - participate in the focused group to be video-recorded during class.
    - not to participate in the focused group.

<b>Name of student</b>	<b>Signature</b>	<b>Date</b>
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- Legal representative's statement of consent: I have read the contents of this consent form. I understand that the student's and guardian's consent do not take away any legal rights in case of negligence on the part of the researcher or any legal fault of anyone who is involved in this study. I further understand that nothing in this consent form is intended to replace any applicable federal, state, or local laws.

<b>Name of legal representative</b>	<b>Signature</b>	<b>Date</b>	<b>Relationship to the student</b>
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<b>Name of Primary Investigator</b>	<b>Signature</b>	<b>Date</b>
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## Informational Letter for Legal Representative

**Title of Research:** Teacher's beliefs on science teaching-learning: Effects on their dialogic scaffolding for enhanced students' argumentation and NOS views

This study aims to gain understanding of science teachers' beliefs on the science teaching and learning which may affect their dialogic scaffolding for an argumentative classrooms and development of students' argumentative skills and views on the nature of science in the Philippines. Your child is being asked to participate in a research study being conducted by Sally B. Gutierrez of Seoul National University because he/she is a student in a school that has agreed to participate in a study aiming to provide benchmark information science teacher educators, K-12 educators, school administrators, and policymakers who can positively transform practices and policies to design professional development efforts that would support and positively transform the science teaching and learning in the Philippines. As the principal investigator, I will give information further explanation about this study to your child. If you sign the student's consent form, you will be authorizing Seoul National University and its researcher to involve you in a research study. You should take your time and carefully read it. You can also take a copy of the student's consent form to discuss it with your family member, attorney or anyone else you would like before you sign it. Do not sign it unless you are comfortable with your child participating in this study.

### 1. Why are we conducting this research?

The goal of this research is to explore the effects of teachers' beliefs on the nature of science teaching and learning and its effects on 1) their dialogic scaffolding of classroom argumentation; 2) development of students' argumentation skills; and 3) students' views on the nature of science. Teacher and student participants will all be from schools in the Philippines.

### 2. How many people are being asked to participate in this study?

Teachers who voluntarily agreed to participate and their respective class to where your child belongs are being asked to voluntarily participate in this study. The whole class including your child will be participating in this research with your proper consent and your child's consent.

### 3. What is being asked of participants?

If you agree of your child's participation, the researcher will observe and capture a video recording of the 12 science classes to which your child belongs and at any time during the observation period, your child may be asked to answer an assessment form related to his/her lessons in science. However, this questionnaire will not be recorded as one of his/her graded outputs in any of his classes.

### 4. How long will this research take place?

The study will last for one month. Each week, four (4) observations will be conducted and anytime within this duration, the researcher will ask the students to answer an assessment form for 40-50 minutes. If they will not finish answering it in the given time duration, they will be given extra time to do it.



**5. What happens if I chose not to participate?**

You child can quit at any time without any penalty. If your child decides to withdraw participation, please contact the researcher immediately.

**6. Are there any side effects?**

There are no potentially harmful risks related to participating in this study. If you have questions about the possible side effects, please contact the researcher immediately.

**7. Are there any benefits to the participants?**

There is no direct benefit of this research to your child. As a result of participation, your child's awareness about school and learning may be increased, particularly in science.

**8. Are there any disadvantages if I choose not to participate?**

Your child may choose not to participate in the study. There are no disadvantages for choosing not to participate.

**9. How will the researcher ensure the information gathered for this research will remain private?**

Ms. Sally B. Gutierrez, a Doctoral Degree and researcher (+822-880-7769), in the Biology Education Department at Seoul National University, is the Principal Investigator of the study and she will carefully manage all participants' classroom and assessment data. The researcher will strive to ensure confidentiality of all data collected through this research. From the data analysis and in any case that findings of this study are to be published or shared at a conference, the researcher will ensure privacy of all participants. Participants' data will be kept confidential unless the information is required to be released during exceptional and compelling circumstances, such as the need to protect the health, life or safety of a participant. At which time, the researchers may need to share participant information with the Seoul National University Institutional Review Board (SNUIRB), who regulates all the research process. By the signing this consent form, you are acknowledging these circumstances and consenting.

All first-hand data such as audio and video recordings and paper data such as observation guides, interview guides, and field notes will be securely stored within five (5) years after completion of the research. Also, all consent forms will be kept within three (3) years after the completion of the research. Moreover, five (5) years after the completion of the research, only coded data will be available for academic purposes primarily as dissertation data, conference presentations, and journal article publication in the future.

**10. Will I receive any payment for participation in this study?**

You, your child and his/her teacher will NOT receive any payment or any gift item for participation in this study. You may not be directly benefited in this study however, your participation may help the researcher in analyzing the status of science education in the Philippines particularly on the stated research interest of this study. On request, you may be informed of the results of the study.



### III. Sample Research Instruments

#### A. Teacher's Beliefs on Teaching and Learning Questionnaire (TBTLQ)

Encircle your level of agreement on each of the following statement. Your level of agreement can be one of the following: SA- Strongly Agree; A-Agree; U-Uncertain;

D-Disagree; and SD-Strongly Disagree.

	Level of agreement				
	SD	D	U	A	SA
1. It is important that I establish classroom control before I become too friendly with students.	SD	D	U	A	SA
2. I believe that expanding on students' ideas is an effective way to build my curriculum.	SD	D	U	A	SA
3. I prefer to cluster students' desks or use tables so they can work together.	SD	D	U	A	SA
4. I invite students to create many of my bulletin boards.	SD	D	U	A	SA
5. I like to make curriculum choices for students because they can't know what they need to learn.	SD	D	U	A	SA
6. I base student grades primarily on homework, quizzes, and tests.	SD	D	U	A	SA
7. An essential part of my teacher role is supporting a student's family when problems are interfering with a student's learning.	SD	D	U	A	SA
8. To be sure that I teach students all necessary content and skills, I follow a textbook or workbook.	SD	D	U	A	SA
9. I teach subjects separately, although I am aware of the overlap of content and skills.	SD	D	U	A	SA
10. I involve students in evaluating their own work and setting their own goals.	SD	D	U	A	SA
11. When there is a dispute between students in my classroom, I try to intervene immediately to resolve the problem.	SD	D	U	A	SA
12. I believe students learn best when there is a fixed schedule.	SD	D	U	A	SA
13. I communicate with parents mainly through report cards and parent-teacher conferences.	SD	D	U	A	SA
14. I make it a priority in my classroom to give students time to work together when I am not directing them.	SD	D	U	A	SA
15. I make it easy for parents to contact me at school or home.	SD	D	U	A	SA
16. If I am not directing classroom events, the most likely result is chaos.	SD	D	U	A	SA
17. My students spend the majority of their seatwork time working individually.	SD	D	U	A	SA
18. For assessment purposes, I am interested in what students can do independently.	SD	D	U	A	SA
19. I invite parents to volunteer in or visit my classroom almost any time.	SD	D	U	A	SA
20. I generally use the teacher's guide to lead class discussions of a story or text.	SD	D	U	A	SA
21. I prefer to assess students informally through observations and conferences.	SD	D	U	A	SA
22. I find that textbooks and other published materials are the best sources for creating my curriculum.	SD	D	U	A	SA
23. I decorate my classroom primarily with posters, pictures, or teaching charts.	SD	D	U	A	SA
24. In my classroom I take care of the learning materials and set them out for students when they need them.	SD	D	U	A	SA
25. It is more important for students to learn to obey rules than to make their own decisions.	SD	D	U	A	SA
26. I am a firm believer in paper-and-pencil tests.	SD	D	U	A	SA
27. I often create thematic units based on the students' interests and ideas.	SD	D	U	A	SA

## B. Teacher's Knowledge and Beliefs on Argumentation Survey (TKBAS)

Encircle your level of agreement on each of the following statement. Your level of agreement can be one of the following: SA- Strongly Agree; A-Agree; U-Uncertain; D-Disagree; and SD-Strongly Disagree.

Knowledge and beliefs on argumentation statements	Level of agreement				
	SD	D	U	A	SA
1. Doing classroom argumentation enhances students' responses.	SD	D	U	A	SA
2. Argumentation between and among students has to be always guided by the teacher.	SD	D	U	A	SA
3. Classroom argumentation demands time.	SD	D	U	A	SA
4. Students with higher intellectual capacities are better in scientific argumentation.	SD	D	U	A	SA
5. Scientific argumentation requires discussion of purely socio-scientific issues.	SD	D	U	A	SA
6. Classroom argumentation is a social process which may change students' understanding of science or views about science.	SD	D	U	A	SA
7. Students' greater proficiency in science can be attained through active classroom argumentation.	SD	D	U	A	SA
8. Scientific argumentation is dependent of the quality and quantity of students' scientific knowledge.	SD	D	U	A	SA
9. Classroom argumentation improves students' recognition of valid claims by presenting data and evidences.	SD	D	U	A	SA
10. Classroom argumentation is a discourse process that builds students' ideas through scientific talk.	SD	D	U	A	SA
11. Argumentation demands persuasion of the audience about a particular claim.	SD	D	U	A	SA
12. All students can participate in classroom argumentation.	SD	D	U	A	SA
13. Classroom argumentation is topic dependent.	SD	D	U	A	SA
14. Classroom argumentation favors only the active students.	SD	D	U	A	SA
15. Students have to convince each other during classroom argumentation.	SD	D	U	A	SA
16. Students' who are able to give reasons have enhanced scientific argumentation.	SD	D	U	A	SA
17. Active students dominate classroom argumentation.	SD	D	U	A	SA
18. Arguments must always be accompanied with scientific theories to enhance validity.	SD	D	U	A	SA
19. Scientific argumentation is a social process which debate knowledge claims.	SD	D	U	A	SA
20. Classroom argumentation improves students reasoning skills.	SD	D	U	A	SA
21. Classroom argumentation plays a crucial role in the effectiveness of students' laboratory activities.	SD	D	U	A	SA
22. Classroom argumentation must be participated by multiple number of students whose interactions lead to building each other's ideas.	SD	D	U	A	SA
23. A single claim from one student can be supported by multiple evidences from different students to establish consensus.	SD	D	U	A	SA
24. Doing classroom argumentation is another method of scientific inquiry.	SD	D	U	A	SA
25. Scientific argumentation enhances students' critical thinking skills.	SD	D	U	A	SA

### **C. Teacher's Beliefs on Teaching and Learning Interview (TBTLI)**

1. How do you maximize student learning in your classroom?  
(learning)
2. How do you describe your role as a teacher? (knowledge)
3. How do you know when your students understand? (learning)
4. In the school setting, how do you decide what to teach and what not to teach? (knowledge)
5. How do you decide when to move on to a new topic in your classroom? (knowledge)
6. How do your students learn science best? (learning)
7. How do you know when learning is occurring in your classroom?  
(learning)

#### **D. Teacher's Support for Classroom Argumentation Interview Guide (TSCAIG)**

Researcher: *“For this interview, we will be asking about how your argumentation practices in class. The interview will take about 20-30minutes. You are welcome to enjoy the refreshments provided throughout the meeting [motion to the juice/water and crackers/snacks] and if you want to take a break any time you can. Remember that you can pass on any of these questions if you feel uncomfortable. In addition, should you decide you want to stop the interview, you can let me know at any time and we will stop the interview. Do you have any questions? Okay, let's begin”*

#### **QUESTIONS:**

- 
1. Do you conduct argumentation teaching in class? How do you prepare for argumentation lessons?
    - a. Do you use socioscientific issues for argumentative lessons?
  
    - b. How much guidance do you provide your students?
  
    - c. What kind of questions do students investigate?
  
    - d. Where do these questions come from?
  
  2. How do you guide students in formulating the argumentations?
    - a. What is the nature of a small group discussion in class?
  
    - b. Are there rules that students have to follow in class?
  
    - c. How do you facilitate the ways on generating evidences by the students?
- 

Researcher: *“Thank you for your time and effort. Do you have any final comments, questions or concerns? Please remember you have my contact information if you have any need to speak with me in the future. Thank you again for your time!”*

## E. Teacher's Dialogic Scaffolding for Argumentation Observation Checklist (TDSAOC)

Instruction: Please use this instrument as a guide for observation of teacher's enactment of dialogic scaffolding in class. Tally the frequency of occurrence of each of the criteria using the second column and write the evidences of occurrences in the third column.

Criteria	Number of times	Statement of Evidence
<b>I. Orienting to hint</b> 1. The teacher points to guide questions that needs to be answered. 2. The teacher notifies the students of prior knowledge before starting their activities. 3. The teacher gives the students' important terms to remember.		
<b>II. Clarifying terms</b> 1. The teacher clarifies to the students their understanding of related terms to be used in the current context. 2. The teacher asks the students related terms needed for better understanding. 3. The teacher asks the students to contextually define scientific terms.		
<b>III. Directing to necessary content</b> 1. The teacher asks the students to specify their evidence based on scientific knowledge. 2. The teacher asks the students how they contextually used all the scientific terms used by the students. 3. The teacher makes explicit explanation of the scientific terms used in the issues presented to the students.		
<b>IV. Presenting argumentative prompts</b> 1. The teacher presents an argumentative statement and challenges students to present their claim. 2. The teacher asked for evidences. 3. The teacher elicits counter-arguments backed-up with evidences.		
<b>V. Probing further</b> 1. The teacher asks for elaborations on students' claims, evidences or justifications. 2. The teacher points out counterarguments presented by the students. 3. The teacher asks varied viewpoints to encourage further presentation of ideas.		
<b>VI. Enabling reflective thinking</b> 1. The teacher directs the students towards real-life connections. 2. The teacher presents statements or questions that invokes reflections from students.		