Alignment of Teachers' Epistemic Understanding and Intended Dialogic Scaffolding of Classroom Argumentation: Implications on Face-To-Face, Open and Distance Learning Environments

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Abstract

Dialogic scaffolding has the capacity to encourage and sustain students' engagement in classroom argumentation. This study explored how the teachers' levels of epistemic understanding were aligned with their intentions for dialogic scaffolding to encourage student's participation in classroom argumentation. Using varied data-gathering procedures such as surveys, classroom observation guides, and interview guides, results showed that the teachers' varying levels of epistemic understanding are aligned with their dialogic scaffolding. Based on the criteria before the selection, each teacher was knowledgeable about the nature with significant exposure to inquiry-based teaching and learning, including classroom argumentation. Results showed that their rationale and nature of dialogic scaffolding were based on their levels of epistemic understanding. Results corroborate previous findings that explicit implementation of classroom argumentation depends on teachers' strong intention and foundation of science content to challenge and stretch the capacities of their students in grasping the meaning of the subject matter. The study foregrounds the possibility of implementing classroom argumentation in any classroom, provided that the teachers can dialogically scaffold the class and lessen the immediate evaluative responses to students' dialogues. The study, therefore, recommends teacher educators increase pre-service teachers' exposure to inquiry approaches to science education, such as argumentation, as an investment for developing their dialogic scaffolding for classroom argumentation.

***Keywords**: classroom argumentation, dialogic scaffolding, epistemic understanding, scaffolding*

Introduction

How teachers interact with students is a major factor in establishing a classroom environment that supports authentic inquiry and develops students' intrinsic motivation to engage in further learning. To understand the factors influencing their inquiry approaches, a wide array of research has focused on exploring the relationships between teachers' knowledge, beliefs, and practices about teaching and learning and classroom argumentation (Capps & Crawford, 2013; Chen et al., 2014). The study's rationale is grounded on the results of previous research, which claimed that there is a "strong relationship between teachers' educational beliefs and their planning, instructional decisions, and classroom practices" (Pajares, 1992, p. 326). According to Evagorou and Avraamidou

(2011), teachers' beliefs can determine their focus on classroom argumentation by just transmitting information rather than allowing time for students to engage. Moreover, Louca et al. (2004) claimed that the context-dependent nature of beliefs is also a factor why teachers' claimed beliefs may not align with what is observed in their classes.

The hypothesis stated in this study was based on previous research which claimed that successful implementation of classroom argumentation requires teachers' constructivist beliefs, enough pedagogical content knowledge (PCK) on classroom argumentation, awareness of the nature of the students, and enough skills in inquiry-based practices (Beyer et al., 2009; Davis & Krajcik, 2005). Having constructivist beliefs, they are able to plan their lessons which would cater to the involvement of students in the construction and co-construction of knowledge. However, the literature shows no evidence of how teachers' different levels of constructivist beliefs are related to their dialogic scaffolding practices.

In a sound classroom learning environment, there exists reciprocity of ideas between and among the teacher and students who "construct the ecology of social and cognitive relations in which the influence between them is mutual, simultaneous, and continuous" (Erickson, 2010, p. 33). The interactions occur in a dialogue that exhibits fair play of discourse using the teacher's questions, verifications, and elaborations and students' extended responses, which support the social and cognitive learning processes. In particular, teacher's dialogic prompts are used as scaffolds tailored fit to the students' current cognitive levels to awaken their prior scientific knowledge and experiences (Muhonen et al., 2016).

Statement of the Problem

Pajares (1992) claimed that beliefs are not likely to change unless challenged. This is supported by earlier claims of McNeill et al. (2016), which state that as teachers strongly hold on to their beliefs, new ones can even be used to justify them. Simply, their beliefs may filter, amplify, or guide their instructional practices (Gess-Newsome, 2015). In terms of classroom argumentation, they may have knowledge of the components (claim, evidence, and justification) and how to promote dialogic discourse but may resist incorporating these when they believe that science involves factual learning that needs to be transmitted to students. On the other hand, their beliefs may guide student-centered engagement in the co-construction of knowledge when they believe that science teaching and learning require students' participation.

In this study, dialogic scaffolding for classroom argumentation is hypothesized to ensure a classroom interaction that sustains students' expressions of argumentative agency. Key to sustainability, however, is the teacher's dynamic assessment of students' responses which serves as cues to formulate dialogic prompts to ensure a sound exchange of ideas through the social process of collective negotiations. Thus, these were also explored for each teacher and were analyzed to understand their intentions for dialogic scaffolding.

Specifically, it aims to answer the following questions:

1. How do the teachers vary in their levels of epistemic understanding?
2. How does the teachers' epistemic understanding align with their intentions for dialogic scaffolding classroom argumentation?
3. What are the implications of teachers' epistemic understanding of their approaches to online and distance education?

Literature Review

Epistemic understanding of dialogic scaffolding

A growing body of research indicates that epistemological beliefs have an impact on teaching and learning approaches and practices in different ways. Literature shows empirical evidence about the consistencies and inconsistencies between science teachers' epistemological beliefs and instructional practices (Capps & Crawford, 2013; Mansour, 2013). This supports the arguments on how their epistemic understanding is related to or would influence teaching and learning processes (Deniz, 2011), especially in terms of their intentions to teach and learn through argumentation (Liu & Roehrig, 2019).

Sandoval (2005) argues that teachers' scientific epistemologies guide their learning and reasoning processes, which further influence their understanding of the process of argumentation, the nature of knowledge and knowing, and their practices. As players in the learning process, science teachers may incorporate argumentation into instruction by reforming their epistemological beliefs and developing their PCK for argumentation.

Previous studies recommend that it should be a norm for teachers to encourage interactions by giving enough dialogic scaffolding (McNeill & Pimentel, 2010) so they can actively share insights about the importance of scientific ideas in their personal lives. This is because, in a dialogic learning environment, students' responses are usually dependent on teachers' prompt statements. As they participate, they become agents of their learning as they participate in the construction and co-construction of knowledge through talk and inquiry (Howe & Abedin, 2013; Wells, 2007). According to Lefstein (2010, p. 10), due to the varying perspectives about dialogic inquiry, a critical argument can reach "competing understandings and further inquiry." Each speaker brings their own set of meanings, views, values, beliefs, and assumptions to the back and forth of discussion. As prime movers of the classroom dialogic interaction, exploring the effects of teachers' knowledge and beliefs on the nature of teaching and learning and on the nature and advantages of classroom argumentation can be explicated through their intentions for dialogic scaffolding for classroom argumentation.

Dialogic learning environment

Although generic principles underpinning the concept exist, such as posing genuine questions and transferring more of the responsibility of learning to the learners (Alexander, 2001, 2005) various aspects such as inquiry and pedagogy

were targeted as potential areas in which dialogue can transform and impact the learning environment. Considering the contemporary works of Vygotsky, it may also 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" (p. 293). Moreover, as Wegerif and colleagues (2009, p. 185) call for dialogic education, the inquiry process is seen not as teaching *through*, but as teaching *for* dialogue so that students become "more open to other voices, more able to question and to listen and so more able to allow new unanticipated meanings to emerge."

Exploring various ways to improve students' classroom engagement is the central element of educational research in recent years. In as much as the dynamics of dialogue have the potential to increase 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 responses that leads to a deeper course of interaction (Nystrand, 1997). In the process, students are encouraged to voice their opinions, consider counterarguments of their peers, and attempt to establish a compromise between others' perspectives and of their own. This happens because, during the interaction process, 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. As such, this study was therefore important as it explicates the teachers' intentions in utilizing dialogues as a scaffolding tool to increase students' agency to participate in classroom discussions.

Dialogic teaching classroom argumentation in online learning

Dialogic scaffolding is seen to be both necessary in face-to-face and in online and distance learning environments. In the face-to-face learning environment, students are allowed to physically seek help from peers and the teacher whenever needed. It may happen during the contingency and fading stages wherein the teacher is still actively involved in the dialogic exchange of ideas.

On the other hand, in online and distance learning, the teacher's scaffolding is mostly embedded in the asynchronous tasks and discussions which may be a source of challenges for students especially when they feel uncomfortable reaching out to their teachers (Cho & Jonassen, 2009; Lee & Choi, 2011). Thus, constant diagnosis of students' needs and learning demands should be done by teachers. A prerequisite to the conduct of this constant diagnosis is the teacher's belief in dialogic scaffolding.

According to Cho and Summers (2012), the usual method of dialogic scaffolding classroom in online and distance learning is posting regular argumentative prompts, responding to student's answers, and encouraging students to engage in written argumentation with each other. It may also be helpful if the teacher recognizes students' contributions, especially in those moments when

they show the initiative to start a discussion with their peers. It is the hypothesis of this study that when teachers possess constructivist beliefs toward dialogic scaffolding for argumentation, even learning via online and distance which is mostly asynchronous can still afford dialogic scaffolding similar to the face-to-face learning environment.

Methodology

Sampling and participants of the study

The purposive sampling technique was used in this qualitative study. The selection of samples was based on the purpose of inquiry in this study which is to understand the alignment of teachers' epistemic understanding and their intentions for dialogic scaffolding for classroom argumentation. Four teachers were selected to represent each of the four basic education programs in the two Philippine secondary basic science education curricula: DepEd Curriculum and DOST-Philippine Science High School (PSHS) Curriculum. Two teachers with assigned pseudonyms, Teacher Don and Teacher Mara, used the DepEd Curriculum, each teaching different programs: General Public High School (GPHS) and the STE-Biology Elective. The two other teachers (pseudonyms: Teacher Loida and Teacher Carlo) were using the DOST-PSHS curriculum with two different programs: PSHS-Regular Biology and PSHS-Biology Elective (Table 1). Except for the PSHS-Biology Elective teacher who is teaching Grade 10, the three other teachers were teaching Grade 8. Each of the curricula was represented by Regular Biology and Biology Elective Classes; thus, the teachers implemented classroom argumentation in two different methods: a content-based approach for the Regular Biology programs and a socio-scientific approach for the Biology Elective Programs. Their topics were also different from each other: basic taxonomy for the GPHS, Mendelian genetics for the PSHS-Biology, stem cell therapy and cloning procedures for the STE-Biology and Bioethics for the PSHS-Biology Elective.

Table 1

Demographic characteristics of the teachers involved in the study

Teachers	Highest Science/ Science Education Degree	Years of Teaching Experience	No. of trainings in science inquiry/ argumentation	Type of curriculum taught
Socio-scientific issues (SSI)-based classes				
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)
Content-based classes				
Case 3: Teacher Don	BS Education (Physics)	5	5	GPHS – Regular Biology (DepEd)

Teachers	Highest Science/ Science Education Degree	Years of Teaching Experience	No. of trainings in science inquiry/ argumentation	Type of curriculum taught
Content-based classes				
Case 4: Teacher Mara	MA Biology Education	11	9	Special Science – Regular Biology (PSHS-DOST)

The teachers' demographic data (Table 1) were also gathered to assess how these affect their knowledge and beliefs of constructivist approaches such as classroom argumentation. Usually, their experiences in teaching and the professional development activities that they have attended are factors that determine their strongly held beliefs. The interview guide was used to understand the variables focused on in this study.

Data sources

Various forms of data, such as surveys, observation guides, and interview guides, were used to explicate the alignment of teachers' epistemic understanding and their dialogic scaffolding for classroom argumentation. These were iteratively analyzed qualitatively using the constant comparison method (Corbin & Strauss, 2014).

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 that align the teachers' epistemic understanding to their dialogic scaffolding.

Interview guides

Teacher's Beliefs on Teaching and Learning Interview (TBTLI). This instrument, which was adapted from Luft and Roehrig (2007), consisted of seven questions about teachers' beliefs about science teaching and learning. This instrument was used to assess the teachers' constructivist beliefs about teaching and learning. It was used to supplement the Teacher's Beliefs on Teaching and Learning Questionnaire (TBTLQ). This was pilot-tested and results revealed that it could be conducted within 40-60 minutes.

Teacher's Support for Classroom Argumentation Interview Guide (TSCAIG). This instrument was a researcher-constructed interview guide composed of two broad questions with three to four sub-questions to prompt the teachers for elaborate responses on how they dialogically scaffold their students' expressions of argumentative agency. Pilot-testing results also revealed using the TSCAIG, the interview could be done within 40 to 60 minutes.

Survey instruments

Teacher's Beliefs on Teaching and Learning Questionnaire (TBTLQ). This 27-item Likert instrument was adapted from Woolley et al. (2004) and was used to assess the teachers' beliefs on teaching and learning in science based on three aspects of their beliefs system, namely: belief in classroom management, belief on the teaching process, and belief on how to interact with students' parents.

Teacher's Knowledge and Beliefs on Argumentation Survey (TKBAS). This instrument 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 of 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 on 13 in-service science teachers and 12 pre-service science teachers for reliability and validity analyses prior to actual data gathering. Table 2 shows the acceptable Cronbach's alpha values for each of their respective components.

Table 2

Results of the reliability and validity analyses for the TBTLQ and the TKBAS

Aspect of teacher's belief system on teaching and learning for the TBTLQ	**Cronbach's alpha**
Classroom management	.732
Teaching process	.721
Interaction with students' parents	.710
Components of the teachers' knowledge and belief system for classroom argumentation from the TKBAS	
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

Classroom observation checklist

Teacher's Dialogic Scaffolding on Argumentation Observation Checklist (TDSAOC). This instrument 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 (Gibbons & Hammond, 2005; Scott, 1998;

Songer et al., 2013) and contained indicators for the teachers' implementation of classroom argumentation using their argumentative dialogic prompts. Using these codes, the observers counted the number of times the teachers provided dialogic prompts, which encouraged students to engage in classroom argumentation supplemented by their respective evidence of occurrences. When some dialogic prompts were not specified in the set of indicators, written notes were provided, which were consolidated after every observed classroom session.

Data analysis

This study used the constant comparison method (Corbin & Strauss, 2014) to develop the themes and subthemes from the coded data transcripts. Inductive and template coding approaches were combined 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 to make a synthesis and finally establish the themes that represented and how the teachers' epistemic understanding and their intentions in dialogic scaffolding for classroom argumentation.

To characterize 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. The subcategories were then merged into three as a general 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. The presentation of these analyses was supplemented with verbatim responses from the interview to enrich the robustness of the data.

One of the criteria for the 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 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 represent their epistemic understanding and intended dialogic scaffolding practices for classroom argumentation. To illustrate, 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 intend to scaffold students' towards 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 into their classroom practice (Evagorou & Dillon, 2011).

Ethical considerations

The approval of the Seoul National University Institutional Review Board was sought prior to the conduct of the study which ensured that all information, data gathering and analysis procedure, data storage, and participants' welfare were ensured. Participants were then informed of the background of the study, the extent of their participation, and how the data that will be obtained from them will be kept and utilized. Their confidentiality was ensured by assigning them pseudonyms from the start of data analysis. Moreover, they were also asked to sign a consent form stating their voluntary participation in the research. In connection, they were informed that they could withdraw anytime they felt discomfort during the data gathering procedure.

Results

SSI-based implementing teachers

Two teachers, namely Teacher Loida and Teacher Carlo, implemented the Biology Elective classes from each curriculum using socio-scientific issues. Analysis of results 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 explicitly framed their Biology Elective classes toward classroom argumentation using socio-scientific issues. They had similar regard for the effectiveness of classroom argumentation as an inquiry-based practice in science education.

The constructivist and experienced teacher encouraged collaborative understanding of concepts

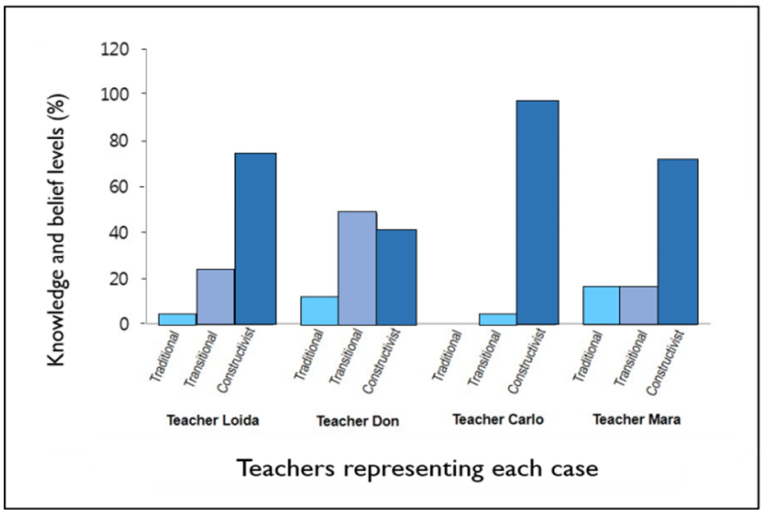
Teacher Loida represented this level of epistemic understanding. Analysis of the demographic data showed that Teacher Loida was the most experienced among the teacher participants having 35 years of teaching and exposure to more or less 20 various inquiry-based teaching and learning seminar-workshops

and training including classroom argumentation (Table 1). During the interview, Teacher Loida regarded herself as a facilitator of learning. Having these views, she puts high regard on her students' abilities (*"I want to become the facilitator. You know, you become more effective if you allow students to take responsibility for their learning…they become empowered"*). In their classroom discussions, she usually acknowledged her students' efforts which served as motivation for them to achieve more. This was also her way to assess the varied learning abilities and 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"*).

Teacher Loida's constructivist beliefs, experiences, and various exposures to inquiry-based instruction and argumentation played major impacts on her implementation of classroom argumentation. With her constructivist views, she was able to act as a facilitator and the interview results 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. Through dialogic scaffolding, her students were enabled to relate their classroom topics to real-life scenarios by linking their socio-scientific topics to their daily lives.

Figure 1

Percentage distribution of the teachers' overall categorized responses for their constructivist levels



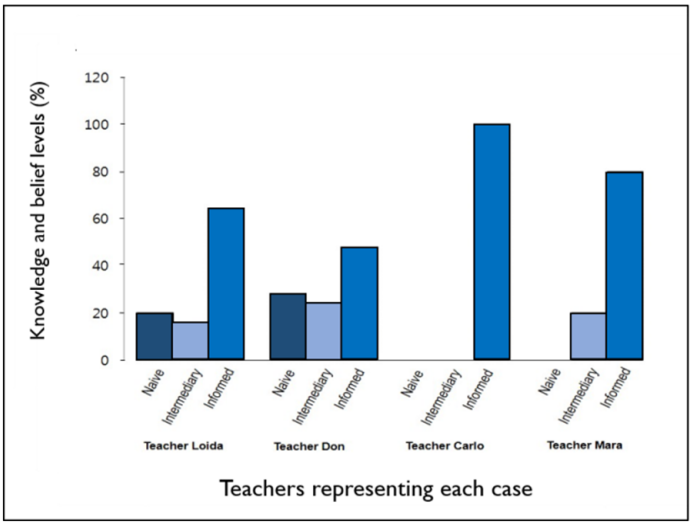
In terms of her knowledge and beliefs on classroom argumentation, she was dominantly knowledgeable and possessed informed views (Figure 2). While it can be observed in Table 3 that though she possessed informed views on the role of argumentation and was knowledgeable enough on the dialogic aspects of argumentation, she was not that confident in the abilities of her students and in the nature of the argumentative process. But these views were not noted during the interview when she acknowledged the role of argumentation in students' learning (*"I believe that teaching through argumentation in biology is one of the best methods since students are asked to express their opinions"*). Moreover,

she acknowledged the development of students' argumentative skills to be equally important to learning science content 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 Mendel's law in high school. I just knew it in college. See, because we are not exposed to issues at that time. So, for me, it is better to expose students with issues aligned to the content."

Figure 2

Percentage distribution of the teachers' overall categorized responses for their levels of knowledge and beliefs on argumentation



As a classroom facilitator, she said that *"I 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 socio-scientific issues and prompted them with critical questions in preparation for classroom discussions. She took advantage of related news articles 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 of 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 3

Level of teachers' knowledge and beliefs on the nature of teaching and learning and the nature and advantages of classroom argumentation

Knowledge and belief components	SSI-based implementing teachers		Content-based implementing teachers	
Nature of teaching and learning	**Teacher Loida**	**Teacher Carlo**	**Teacher Don**	**Teacher Mara**
Management	Constructivist	Highly Constructivist	Transitional	Constructivist
Teaching	Highly Constructivist	Highly Constructivist	Transitional	Highly Constructivist
Parent	Transitional	Constructivist	Transitional	Constructivist
Classroom argumentation				
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

She mentioned some barriers to classroom argumentation, such as large classes and time constraints (*"large classes that we have here in the Philippines…and hmm…lack of time"*), but being an experienced teacher, her familiarity with the diversity of students' characteristics was instrumental to readily provide dialogic support (*"give them [students] questions that support or counter-argue previous student's opinions"*). She believed dialogic scaffolding "prompts the students the idea to speak up." She 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."*

The highly knowledgeable and highly constructivist teacher employed a culture of negotiation

This category was represented by Teacher Carlo, a Junior Faculty member, with eight years of teaching experience who was already exposed to more than 10 training on inquiry-based teaching and argumentation. He holds a bachelor's degree in Biology and two master's degrees: a master's in education major in Environmental Science and a master's in Bioethics. 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, Metro Manila. According to him, during the time of the study, he just resumed teaching after graduating with

his master's degree in Bioethics 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 the head of 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 among the teachers in this study (Table 3; Figure 1) and his constructivist views were influenced by his academic exposures, especially in bioethics backed up by a solid foundation of biology content and his knowledge of pedagogy. He firmly believed that because his students were inclined to the science field, *"they should be exposed to how to exercise their decision-making since they [must] possess the innate sense of self-awareness towards ethical issues.*" 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 socio-scientific issues.

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 and the students' advanced reading tasks which served as guides *"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 a 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 of 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 about 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."* 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."*

As a constructivist teacher, he established a culture of negotiation during their classroom argumentation through his short but open-ended dialogic prompts. Moreover, his explicit decision to implement argumentation, followed that his dialogic scaffolding practices established the classroom into a social and verbal activity which facilitated the development of students' reasoning skills during their expressions of argumentative agency (Osborne, 2010; Sampson & Clark, 2009). As he contingently and dialogically prompted the students to present their claims with evidence, they were able to identify the strengths and weaknesses of their insights which were later used to converge and achieve consensus.

Content-based implementing teachers

The other two teachers observed in this study implemented two different types of curricula, 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 their rationale for dialogic scaffolding.

The teacher who is in transition from traditional to constructivist provides conceptual reflective questioning

Teacher Don is a teacher representing those with a transitional level of epistemic understanding. He holds a bachelor's degree in Education majoring in Physics and 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 the majority of the public high schools in the Philippines.

Results of the analysis showed that Teacher Don was the least constructivist among the four teacher-participants (Figure 1). However, his beliefs in 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 classroom argumentation served as evidence for his desire 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 knowledge construction (Jiménez-Aleixandre et al., 2000) rather than just repeaters of the factual knowledge to confirm textbook explanations (van Zee & Minstrell, 1997). Compared to the other teachers, students' responses in Teacher Don's classes were short and unelaborated. However, he was able to 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.

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 a *traditional* teacher, but he acknowledged the effectiveness of constructivist teaching, especially when he observed the classes of Teacher Loida. Thus, he was optimistic about 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 at 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 to 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 with the constructivist views, and these were also supported by the results of his interview when he said that he is always open to clarifications and involved the parents in setting the rules, particularly in his advisory class.

In terms of his knowledge and beliefs on argumentation, he held transitional knowledge and beliefs in classroom argumentation (Figure 2). The interview results slightly contradicted his transitional views based on his responses to the survey instrument regarding the role of classroom argumentation in science learning. Analysis showed that he could be regarded as possessing 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 socio-scientific 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 debate was used as a strategy to implement classroom argumentation.

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."*

The constructivist and knowledgeable teacher provided flexible affirmations of students' ideas

Just like Teacher Don and Teacher Carlo, Teacher Mara can also be considered a knowledgeable teacher who is in the same school as Teacher Carlo. With 11 years of teaching experience, she had 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 specializing in Biology. According to her, she has been teaching genetics classes from the start of her teaching career to regular Grade 10 students but since the country's implementation of a new 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 the 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. 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."* The 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 evidence."* 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 was 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."

In the interview, she mentioned that 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 the 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, 2002). Her responses to the interview about changing her role from a sole transmitter of knowledge to a facilitator of learning and her instructional practices were aligned with 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.

Her dialogic prompts were mostly framed to elicit her students' responses with the goal of 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 attempting 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.

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 (Engle & Conant, 2002). Learners' 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 to queries for collective and dynamic thinking.

Discussion

The value of teachers' beliefs on dialogic scaffolding on their implementation of classroom argumentation

Capitalizing on language as an essential tool in meaning-making in the classroom, the results of this study showed that as teachers recognized the value of joint knowledge construction, they intentionally harnessed the power of dialogic exchange to scaffold the discussion. Their students' participation resulted from their dialogic prompts which created interaction space and gave direction for students' thinking. Dialogic prompts produced a discursive tool which enabled students to reflect, clarify, expand others' ideas (*Why do you think so, do you mean to say…*), establish collaborative thinking (*Can you add more?*), and negotiate differences in perspectives (*Do you agree/disagree? Why?*).

Results show that the four teachers involved in this study had different views on the nature of science teaching and learning. Based on the survey and interview data, Teacher Carlo had the most constructivist views on teaching and learning (Figure 1) and the most knowledgeable and most informed about classroom argumentation (Figure 2). These survey results align with the interview results when he mentioned that knowing the nature of his Bioethics elective class, he prioritized classroom argumentation as the most appropriate teaching method to encourage students' participation. These results align with previous research which claimed that teachers' constructivist beliefs are not associated with their skills but more so with their personal sense of the benefits of constructivism (Windschitl, 2002).

Combined analyses of all data confirmed that Teacher Carlo upholds his beliefs on constructivism by making his biology class a venue for students to engage as he scaffolded and encouraged them to be active agents in argumentative dialogues (Wood & Turner-Vorbeck, 2014). His views were also influenced by his academic exposures and experiences which supplemented his firm beliefs in the effectiveness of constructivist teaching. Holding on to the constructivist view, knowledge construction involved participatory and social negotiation among his students.

In the case of Teacher Loida, her experiences and various exposures to inquiry-based instruction and argumentation played a big factor in her implementation of classroom argumentation. Her dialogic scaffolding helped her students become active participants in knowledge construction. Moreover, she encouraged the students to relate their classroom topics to real-life scenarios making students become more aware of the direct implications of their scientific knowledge.

In the case of Teacher Mara, she recognized the importance of student interactions as she scaffolded the reorganization of their prior knowledge

against their understanding of the new information. She gave her students 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, 2002). Her response to the interview about changing her role from a sole transmitter of knowledge to a facilitator of learning and her instructional practices were aligned with 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.

Results of the analysis conducted to show the overview of teachers' beliefs on the nature of teaching and learning revealed that Teacher Don was the least constructivist among the four teacher-participants in this study. Besides acknowledging the fact that he is a novice in the field of biology education, his pre-conception that argumentation is primarily suited to biology is a major factor in his decision to implement inquiry approaches such as classroom argumentation. Moreover, this was also a factor of having insufficient knowledge of biological concepts. He held the misconception that his knowledge would not suffice his skills to make decisions to create positive impacts on the learning process. As he mentioned in the interview, these inherent beliefs were translated into the major fallacy that some teachers' instructional approaches rely on the capacities of the students (Kirschner et al., 2006).

Putting all these data together conforms to the idea of Guskey (1986) who claimed the direct relationship between beliefs and behaviors. Moreover, the interview data showed that the teachers' ideas, beliefs, and practices determined their decisions in the classroom. Their perceptions of the advantages of constructivist teaching and learning shaped their dispositions and approaches to their teaching strategies (Richardson, 1996). Primarily Teacher Carlo and Teacher Loida framed their discussions for dialogic interactions which supported the students to link their scientific understanding to real-life experiences. As they facilitated their students' interactions, they allowed them to interact using what they already know which increase their interests and motivation (Forbes et al., 2001).

Based on the survey questionnaire and the interview, teachers in this study were asked about their beliefs on the capacities of their students to engage in classroom argumentation. It was found that Teacher Carlo and Teacher Loida strongly believed that all students can engage in classroom argumentation. Through these beliefs, they were able to frame their instructional strategies (Nespor, 1987) to provide enough opportunities for student-student interaction (Alozie et al., 2010). Having constructivist views who believed in 'knowledge construction,' they were able to harness the power of their dialogues to scaffold and engage their students in critical thinking (McNeill et al., 2016). Moreover, they did not sacrifice the significance of dialogic discussions in improving students' communication skills and reasoning abilities (Jiménez-Aleixandre & Erduran, 2007). Observation data show that students became "learners with agency" rather than passive ones (Polman, 2004, p. 463). In fact, they utilized conversational structures to extend the inquiry process in their dialogic

exchanges to assess the students' conceptual understanding (Polman, 2004). Taking into consideration Teacher Mara's case, her dialogic scaffolding leveraged the classroom talk not to evaluate students' responses. She utilized students' 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 et al., 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. Through dialogic scaffolding, 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).

Similar content-based argumentation was observed in Teacher Don's class and analysis revealed that most of his dialogic prompts were reflective statements which enabled the students to express their personal thoughts on the implications of their lessons. 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 knowledge construction (Jiménez-Aleixandre et al., 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 to pick up and appropriate the few critical points raised by some students to extend their discussions instead of providing evaluative prompts.

Implications of the teachers' beliefs on face-to-face, online, and distance learning

Results show that teachers possess different beliefs on dialogic scaffolding for classroom argumentation. In science classrooms, scientific argumentation as a reform-based strategy that facilitates student engagement in epistemic practices relies much on the teacher's beliefs that reflect how they value learning (Osborne et al., 2004). In face-to-face learning, their beliefs determine how they structure their routines and in the case of classroom argumentation, they may implement dialogic scaffolding that is responsive to the moment-by-moment interactional needs of the students. On the other hand, for open and distance learning, they mostly implement dialogic scaffolding through the prompts that they post and how they sustain the discussion through their occasional involvement in the students' discussion. This dialogic scaffolding can be equated to the fading (van de Pol et al., 2019) stage of dialogic scaffolding where students are provided with the independence to learn by themselves, still with the involvement of the teacher when the need arises.

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 be devoid of the recitation method. Through dialogic scaffolding, students are provided with enough opportunities to listen, question, and critique their viewpoints. This also supports previous claims that

teachers' provision and promotion of appropriate dialogues empower students to think and learn (Alexander, 2005). Thus "success at school may be more a function of the quality of dialogue with a teacher and the opportunities it creates for 'interthinking' rather than a function of the child's ability or the teacher's skill" (Sewell, 2011, p. 271).

This study hypothesized that traditional teachers have the tendency to formulate dialogic statements with predetermined answers and thus wait for students' responses with immediate evaluative prompts. As the teacher-participants possessed certain levels of constructivist views, their discussions were redirected from the usual factual cognitive to the social constructivist learning process and the students practiced their argumentative agencies in a more open and participatory discussion (Teo, 2016, 2019). The dialogue was used to foster responsibility and a scaffolding tool to increase the 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 the discussion.

Based on the results of this study, these teachers' beliefs on dialogic scaffolding to classroom argumentation in the face-to-face learning environment can also be applied when they shift to the open and distance learning environment. This is because, pedagogical beliefs are claimed to be stable and resistant to change (Pajares, 1992). Beliefs, which are said to be personal constructs can provide an understanding of teachers' practices, influence their instructional decisions and classroom management, and serve as a lens for understanding their classroom events (McNeill & Pimentel, 2010; Pajares, 1992). Moreover, they shape teachers' cognition and behaviour as well as guide their planning of classroom practices and activities (Calderhead, 1995).

Conclusion

To conclude, the study explored how teachers' epistemic understanding was aligned to their provision of dialogic prompts to scaffold the students' critical, agentive, collaborative, and reflective in evaluating and sensemaking their prior knowledge against new ones. Moreover, the study concludes that 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 their reasoning skills. Finally, through dialogic scaffolding, students can be provided with a learning environment where they are fully allowed to develop communication skills with evidence-based arguments on their science topics.

However, with the limitations of the small sample size, these conclusions can only encompass the general characteristics of some of the teachers in this case study. The cases can serve as representatives to teachers with similar characteristics in terms of the length of their teaching career, the science field they are teaching, or the level of education they have attained which may influence their epistemic beliefs. Based on the results, this study recommends

continuously updating teachers' epistemic understanding of knowledge construction through inquiry approaches. In the case of the in-service teachers, these can be through regular exposure to emerging inquiry-based teaching approaches such as dialogic scaffolding. For pre-service teachers, the explicit inclusion of dialogic scaffolding strategies in their curriculum can be a potential factor for their enhanced exposure to this teaching pedagogy.

Limitations of the Study and Future Directions

As qualitative research, this study utilized thematic and exploratory analyses of the teachers' epistemic understanding and intended practices for dialogic scaffolding of classroom argumentation in high school biology. With the robust amount of data, the study still poses some limitations. First, despite the accuracy of the themes that were generated for each case, not all cases with similar teacher characteristics may be used to describe them. Second, purposive sampling may be appropriate to the nature of the study; however, it may not be used to present a general picture of all the Philippine schools represented by each case. Nonetheless, the cases in this study can share similar features, especially in the general public high schools in urban areas like Metro Manila where most of the large schools in terms of population are located. Future studies can therefore be done to explore more extensive data which may be quantitatively analyzed in terms of the variables presented in this study. Future studies can also explore students' argumentative agencies when they are being scaffolded by their teachers during their classroom discussions.

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