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Science Teachers' Dialogic Practices in Senior High School STEM Science Classrooms

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The integration of diverse discourse strategies is crucial for fostering learning environments where students actively engage in scientific practices, interact with scientific data, and use the technical language of science. This descriptive quantitative study examines the dialogic practices of science teachers in senior high school STEM science classrooms, focusing on the frequency and nature of these practices as perceived by both teachers and students. Survey data were collected from 310 STEM students and 8 science teachers at a private institution in Cavite City, Philippines. A ten-item survey scale assessed the implementation of productive dialogic practices, with item-level analyses conducted using Mann-Whitney U-tests to examine differences in perceptions. Results revealed that students consistently rated the frequency of all ten dialogic practices higher than teachers, with significant disparities in specific moves, including 'Invite Others to Build on Ideas,' 'Build on Ideas,' 'Make Reasoning Explicit,' and 'Challenge.' Furthermore, teachers' years of experience exhibited a positive monotonic relationship with their perceived frequency of dialogic practices. These findings highlight the importance of critically examining how dialogue is enacted and positioned within Filipino science classrooms, emphasizing the need for enhanced awareness and implementation of effective dialogic strategies.

Keywords: dialogic practices, classroom dialogue, dialogic teaching, STEM classrooms, science education

INTRODUCTION

Dialogic teaching has emerged as a cornerstone of effective science education, with research consistently highlighting its importance in fostering active student engagement, critical thinking, and deeper conceptual understanding (Alexander, 2020). In contrast to traditional didactic approaches, dialogic teaching emphasizes collaborative knowledge construction, where students are encouraged to articulate their ideas, engage in scientific reasoning, and participate in discourse that mirrors the practices of professional scientists (Scott & Mortimer, 2005). This shift from unidirectional knowledge transmission to interactive learning is particularly vital in science

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classrooms, where the ability to communicate and reason scientifically is as essential as mastering subject content. For senior high school STEM (Science, Technology, Engineering, Mathematics) students, who are often on a path toward careers in scientific fields, the development of these dialogic competencies is crucial.

Although dialogic interactions have been shown to enhance student participation and understanding in science education (Howe et al., 2019), research in the Philippine context remains limited, particularly with respect to the unique linguistic and cultural characteristics of Filipino classrooms. Existing studies, such as the work of Garcia et al. (2019), have made significant strides by developing preliminary frameworks for assessing teachers' use of dialogic moves, such as revoicing and reflective toss, in multilingual STEM classrooms. These studies underscore the necessity for culturally adaptive coding schemes to capture the complexities of classroom discourse in the Philippines, and they highlight the critical role of teachers as facilitators of productive discourse that shapes the quality and depth of student interactions.

As the demand for 21st-century skills in STEM fields grows, it is increasingly important that Filipino students develop the ability to think critically, collaborate effectively, and communicate like scientists. This aligns with broader global educational trends that prioritize innovation, communication, and collaborative problem-solving in STEM education. As such, there is an urgent need to examine and refine classroom practices to better meet these demands. By exploring the current state of dialogic teaching in senior high school STEM classrooms, this study aims to provide valuable insights that can inform the development of policies and professional development initiatives to enhance the quality of science education in the Philippines.

Context and Review of Literature

Dialogic Practices in Science Education

Empirical studies investigating classroom dialogue across a range of educational settings have long underscored the centrality of discourse in promoting active student engagement, critical thinking, and collaborative learning. From dialogic inquiry (Wells, 1999; Wells et al., 2021), scientific argumentation (Osborne et al., 2019), exploratory talk (Knight & Mercer, 2015; Boblett, 2018; Liang & Fung, 2020), critical dialogue (Odutayo & Yusuf, 2020), to dialogic teaching (Alexander, 2018; García-Carrión et al., 2020; Palomino et al., 2025), research consistently positions classroom dialogue as a powerful tool for student-centered learning. In these environments, student contributions are central to the learning process, facilitating opportunities for learners to engage in cognitively challenging discussions, build knowledge collectively, and express their ideas in a coherent and reasoned manner.

The importance of dialogic practices becomes particularly pronounced in science education, where dialogue fosters a dynamic, interactive, and evidence-based learning environment. In science classrooms, dialogue takes the form of argumentation and debate grounded in empirical evidence, which mirrors the specialized communication practices of scientists. As Lehrer and Schauble (2006) argued in their "science-as-practice" framework, science education should immerse students in the roles of scientists, where they actively engage in inquiry, pose questions, gather and analyze data collaboratively, evaluate evidence, and communicate new understandings that are meaningful to their lives and interests. This process requires a unique kind of dialogue—one that is deeply rooted in critical thinking and intellectual rigor.

In addition, the role of dialogue in shaping conducive learning environments in science education is seen in collaboration and inclusivity (Kang & O'Neill, 2018; Howe et al., 2019, Sousa, 2021). Because science is a collaborative endeavor, dialogue fosters a sense of community in the classroom where students are encouraged to learn from the perspectives of one another and build scientific knowledge co-constructively (Carrión et al., 2020). This is particularly significant in diverse classrooms, where the exchange of ideas and perspectives can lead to richer, more robust scientific understanding. As science is inherently collaborative, the dialogic nature of STEM classrooms mirrors the real-world practices of scientific communities, preparing students to become not only consumers of knowledge but active contributors to the creation of scientific knowledge.

Beyond fostering collaboration, a qualitative study by Ching-Chiang and Fernández-Cárdenas (2020) further highlights how high school teachers can reduce marginalization and promote inclusion through dialogic and transformative learning practices. A similar study was conducted among native American and Caucasian college students in the height of the global pandemic (Hembrough & Cavanagh, 2022). These strategies emphasize the importance of creating classroom environments where all voices are heard, and diverse perspectives are valued, ensuring that every student can actively participate in the learning process.

A research by Mercer et al. (2021) demonstrated that teachers who effectively use talk moves—such as prompting students for elaboration or encouraging peer interactions—can enhance student participation and foster deeper cognitive engagement. Hogan et al. (2020) highlighted how increasing student agency in dialogic settings, by allowing students more control over the direction of conversations, leads to higher levels of student engagement and more meaningful learning experiences. Additionally, studies on teacher pedagogical content knowledge emphasize the importance of teachers' understanding and implementation of STEM practices (Gözüm et al., 2022), as well as enhancing competency in designing learning activities in STEM education (Koocharoenpisal, 2023). Professional development has also been shown to play a crucial role in improving dialogic teaching. Kelly and Green (2022) found that targeted professional development programs enhance teachers' abilities to facilitate complex, interactive classroom discussions, fostering a learning environment that promotes critical thinking and collaborative problem-solving.

In the Philippines, the integration of dialogic practices into science education has been a subject of interest. A study by Marfu et al. (2021) explored how collaborative activities, such as questioning and brainstorming, can develop critical thinking skills among Filipino students. The research highlighted that these dialogic practices are essential for fostering effective decision-making and problem-solving abilities.

Ultimately, dialogic practices in STEM classrooms offer profound potential to reshape how students engage with scientific content, think critically about scientific issues, and communicate in ways that reflect the collaborative, evidence-driven nature of modern scientific inquiry. This emphasis on dialogue, reasoning, and collaboration provides an important framework for the future of science education.

Theoretical Framework

The theoretical foundation of this study is primarily grounded in Vygotsky's sociocultural theory, which emphasizes the social and communicative nature of human learning and cognitive development. According to Vygotsky (1978), both learning and cognitive development are processes inherently shaped by the interactions between individuals and their surrounding environments. These processes are mediated through social interactions, where learners engage with more knowledgeable individuals who provide the context for learning. Through collaborative activities and dialogues, learners are not only able to internalize new knowledge but also develop higher mental functions.

Central to Vygotsky's perspective is the concept of scaffolding, wherein more knowledgeable others—such as teachers or peers—support learners in acquiring new skills and understanding. This process allows students to progress from their current level of understanding to a more advanced one, facilitated by the guidance and feedback of others. Such interactions are critical in the context of dialogic teaching, where dialogue serves as the primary means by which learning takes place. This collaborative exchange of ideas within a community of practice reflects the essence of Vygotsky's notion of intermental activity—where knowledge is co-constructed through social interaction. Moreover, Vygotsky underscores the importance of cultural and linguistic factors in shaping cognitive development. He argues that knowledge is not only constructed through interpersonal interaction but also influenced by the cultural tools, including language and social practices, available to individuals. Language, in this view, is not merely a tool for communication but also a crucial cognitive tool that facilitates thinking and problem-solving. It enables learners to organize their thoughts, reflect on their actions, and articulate their understanding, making it central to the process of learning and cognitive development.

In the context of science education, Vygotsky's framework highlights the role of classroom dialogue in facilitating not just content acquisition but also the development of scientific thinking and reasoning. Dialogic teaching, which prioritizes open, reflective, and reciprocal exchanges among students and teachers, aligns with Vygotsky's assertion that intellectual development occurs through social processes.

Research Questions

The principal objective of the study is to present an assessment of teachers' dialogic practices in senior high school STEM science classrooms. Hence, it is informed by the following research questions:

1. How often are productive dialogic practices implemented by teachers in the classroom?
2. Is there a significant difference between teachers' and students' perceptions in accordance with the use of dialogic practices?
3. How do years of teaching experience correlate with the teachers' dialogic practices in the classroom?

METHOD

Research Design

The study employed a descriptive quantitative research design, utilizing a survey instrument to systematically collect and analyze numerical data. Informed by a quantitative approach, the study sought to provide an objective analysis of the nature, frequency, and perceptions of dialogic practices in senior high school STEM classrooms. Further, descriptive quantitative survey approach was chosen to systematically capture the nature and extent of dialogic practices among senior high school STEM science teachers. This method allows for structured data collection that can yield clear, comparable, and analyzable insights even from a modest sample (Creswell & Creswell, 2018). The primary aim of the study is to explore plausible patterns and provide an initial empirical snapshot of how dialogic teaching manifests in STEM classrooms. Even with a limited number of respondents, a survey enables researchers to establish baseline data and generate insights that can inform future studies or interventions. While discourse analysis is more interpretive and suited for in-depth examination of language-in-use (Gee, 2014), and mixed methods offer both breadth and depth, the latter is often more resource-intensive and complex, making it less practical for small-scale exploratory studies (Tashakkori & Teddlie, 2010).

Research Locale and Participants

The study involved 310 senior high school STEM students and 8 science teachers in a private basic education institution located in Cavite City, Philippines. The student respondents in this study included 170 Grade 11 and 140 Grade 12 STEM students. Among the student respondents, 177 (57.5%) were male, and the majority (45.8%) were 16 years old.

With regards to the demographic profile of the teachers, six among the respondents (85.7%) were male, and only one (14.3%) was female. Majority of the teachers (57.1%) had between six to ten years teaching experience. Furthermore, 85.7% of the teachers reported to have exposure with professional development programs. This high percentage of participation can be attributed to the teachers' extensive experience in the field of science education, with most having taught for nearly a decade.

Survey Instrument

The survey questionnaire used in this study consisted of a ten-item Likert scale designed to assess the frequency with which teachers implement productive dialogic practices in the classroom. The items were informed by the ten dialogue categories present in the analytical framework of the Teacher Scheme for Educational Dialogue Analysis or T-SEDA (Hennessy et al., 2016). These categories are: (1) express or invite ideas; (2) invite others to build on ideas; (3) build on ideas; (4) invite reasoning; (5) make reasoning explicit; (6) coordination of ideas and agreement; (7) connect; (8) challenge; (9) guide the direction of dialogue or activity; and (10) reflect on dialogue or activity.

Students completed the student version of the questionnaire, which assessed their perceptions of teachers' dialogic practices, while teachers filled out the teacher version, serving as a self-assessment of their own practices. The parallel structure of the survey items allowed for direct comparison between teachers' and students' perceptions of dialogic practices. For instance, an item in the teacher version was: *"I implement critical-thinking activities where my students can behave like scientists and talk in a manner befitting a member of the scientific community."* The corresponding item in the student version was: *"My science teacher implements critical-thinking activities where we can behave like scientists and talk in a manner befitting a member of the scientific community."* Respondents rated their responses on a scale from 1 to 10, with 1 representing the least frequent occurrence and 10 representing the most frequent.

The face and content validity of the instrument were evaluated by a senior high school science teacher with experience as a science academic coordinator at a private university in Cavite City, Philippines. Furthermore, the instrument's reliability was assessed using Cronbach's alpha, yielding an excellent reliability score of $\alpha = .92$.

Data Collection

Prior to the administration of the survey, ethical considerations and procedures were first ascertained. First, ethical approval was established with the institution's research ethics review committee. Since the research required the involvement of human respondents, some of which were minor, there was a need for thorough establishment of both the informed consent procedure and forms. Assent forms addressed to the parents and guardians of all senior high school respondents were written by the researcher, and then disseminated by the schools' appointed Head of Research through the institution's learning management system.

All respondents were provided sufficient information regarding the objectives of the study and the role that they will partake. This included procedures, possible benefits, and appropriate systems designed to exercise the confidentiality and anonymity of the respondents. The researcher conveyed this information through an informed consent procedure: a recorded video for students and an in-person discussion for teachers. Following these communications, informed consent forms were distributed to all respondents to formally establish their written consent to participate in the study.

Data sources that are aimed to address all research questions were gathered through the responses from the survey questionnaire. In the case of the students, the survey was administered by their adviser during the homeroom period. For the teachers, the survey was facilitated by the researcher.

Data Analysis

Survey responses were initially analyzed separately for students and teachers using descriptive statistics. To assess the overall differences in perceptions of dialogic practices, mean and standard deviations were calculated. The Shapiro-Wilk test of normality indicated that the scores for both students and teachers were not normally distributed. Consequently, the non-parametric Mann-Whitney U-test was applied for further analysis. Specifically, item-level analyses were conducted using independent sample Mann-Whitney U-tests to explore the differences in how students and teachers perceive the frequency of dialogic interactions in the classroom. This test is robust to violations of normality, making it suitable for the data. Lastly, to investigate the relationship between teachers' years of teaching experience and their dialogic practices, a Spearman Rank correlation was employed. This non-parametric test is appropriate for assessing monotonic relationships between ordinal variables and was used to determine whether teaching experience influenced teachers' reported dialogic practices.

It is important to note that this study utilized self-reported survey data to investigate science teachers' dialogic practices. While self-report instruments are valuable for capturing participants' perceptions and experiences, they are vulnerable to certain types of response bias. As noted by Podsakoff et al. (2003), self-reported data may be affected by social desirability bias, consistency motifs, or recall errors, which can threaten the validity of the data by inflating or distorting the relationships between measured variables. In this context, teachers may unintentionally overstate their use of dialogic practices to align with perceived expectations or professional norms.

FINDINGS

Results of descriptive statistics

Table 1
Students' and teachers' perceived frequency of dialogic practices in the classroom

Dialogic Practice	Student (n=310)		Teacher (n=7)	
	M	*SD*	*M*	*SD*
DP1	9.39	1.03	9.00	1.53
DP2	9.34	1.12	7.43	1.13
DP3	9.50	0.97	8.86	1.35
DP4	9.21	1.22	8.00	2.83
DP5	8.82	1.57	6.86	2.67
DP6	9.17	1.20	8.57	1.72
DP7	8.76	1.82	7.29	2.36
DP8	9.55	0.85	9.57	0.79
DP9	9.09	1.39	8.14	2.48
DP10	9.25	1.21	8.86	1.46

Note. Express or Invite Ideas (DP1), Invite Others to Build on Ideas (DP2), Build on Ideas (DP3), Invite Reasoning (DP4), Make Reasoning Explicit (DP5), Coordination of Ideas and Agreement (DP6), Challenge (DP7), Connect (DP8), Guide Direction of Dialogue or Activity (DP9), and Reflect on Dialogue or Activity (DP10)

Table 1 presents the assessments from both students and teachers regarding the frequency with which dialogic practices are implemented in the classroom. From the data, it can be inferred that the majority of the senior high school STEM students perceive dialogic practices as being implemented frequently in their classrooms, with little variation across the different practices.

Notably, the dialogic practice 'Connect' received the highest mean scores from both students (M = 9.55) and teachers (M = 9.57), indicating its strong presence in classroom interactions. In contrast, the lowest mean scores differed between the two groups, with students reporting the least frequency for the practice of 'Challenge' (M = 8.76), while teachers rated 'Make Reasoning Explicit' (M = 6.86) as the least frequently implemented practice.

Results of item-level significance test

The table presented below provides a comprehensive overview of the survey items, teacher and student responses, and the results of item-level significance tests conducted using the non-parametric independent samples Mann-Whitney U-test. The analysis reveals that, for most of the dialogic practices, there were no significant differences between the responses from students and teachers. However, significant differences were observed for survey items 2, 3, 5, and 7, which correspond to the dialogic moves 'Invite Others to Build on Ideas,' 'Build on Ideas,' 'Make Reasoning Explicit,' and 'Challenge,' respectively.

Table 2
Item descriptions, teacher and student responses, and item-level significance tests

	Survey Items (S = student item) (T = teacher item)	Student (n=310)		Teacher (n=7)		p^a
		M	SD	M	SD	
1.	S: My science teacher invites us to express our ideas, views, thoughts, interests and feelings. T: As a science teacher, I invite my students to express their ideas, views, thoughts, interests and feelings.	9.39	1.03	9.00	1.53	.251
2.	S: My science teacher invites us to expand on our ideas and the dialogic contributions of our classmates. T: As a science teacher, I invite my students to build on their ideas and the dialogic contributions of their classmates.	9.34	1.12	7.43	1.13	<.001**
3.	S: My science teacher builds on our ideas by clarifying or expanding on our answers and dialogic contributions. T: As a science teacher, I build on my students' ideas by clarifying or expanding on their answers and dialogic contributions.	9.50	0.97	8.86	1.35	.042*
4.	S: My science teacher implements critical-thinking activities where we can behave like scientists and talk in a manner befitting a member of the scientific community. T: As a science teacher, I implement critical-thinking activities where my students can behave like scientists and talk in a manner befitting a member of the scientific community.	9.21	1.22	8.00	2.83	.146
5.	S: My science teacher prompts us to critique and evaluate on our classmates' arguments or position through explicit reasoning. T: As a science teacher, I prompt my students to critique and evaluate on their classmates' arguments or position through explicit reasoning.	8.82	1.57	6.86	2.67	.017*
6.	S: My science teacher coordinates and synthesizes various ideas collected from the dialogic contributions of the class. T: As a science teacher, I coordinate and synthesize various ideas collected from the dialogic contributions of the class.	9.17	1.20	8.57	1.72	.102
7.	S: My science teacher encourages us to challenge us classmates' perspectives when we disagree with their arguments. T: As a science teacher, I encourage my students to challenge their classmates' perspectives when they disagree with their arguments.	8.76	1.82	7.29	2.36	.029*
8.	S: My science teacher connects our current lesson with previously discussed topics and discuss plausible relationships between the old and current concepts T: As a science teacher, I connect our current lesson with previously discussed topics and discuss plausible relationships between the old and current concepts.	9.55	0.85	9.57	0.79	.480
9.	S: My science teacher guides the direction of dialogue or activity by providing dialogic prompts such as *"Instead of doing this, maybe we can…"* or *"How about we focus on this topic first?"*.	9.09	1.39	8.14	2.48	0.123

	T: As a science teacher, I guide the direction of dialogue or activity by providing dialogic prompts such as *"Instead of doing this, maybe we can…"* or *"How about we focus on this topic first?"*.					
10.	S: My science teacher gives us time to reflect on our dialogue and activity and how they helped us learn scientific concepts. T: As a science teacher, I give my students time to reflect on their dialogue and activity and how they helped them learn scientific concepts.	9.25	1.21	8.86	1.46	0.179

Note. *p < .05, **p < .001
a = Independent samples Mann-Whitney U test

Results of Spearman Rank correlation

Table 3
Correlation of years of teaching experience and perceived dialogic practices in the classroom

Dialogic Practice	Years of Teaching Experience	
	Spearman's rho	*p*
Express or invite ideas	0.66	.107
Invite others to build on ideas	0.91	.005*
Build on ideas	0.54	.213
Invite reasoning	0.56	.188
Make reasoning explicit	0.91	.004*
Coordination of ideas and agreement	0.81	.026*
Challenge	0.8	.015*
Connect	0.37	.410
Guide direction of dialogue or activity	0.71	.074
Reflect on dialogue or activity	0.50	.252

Table 3 presents the relationship between teachers' years of teaching experience and the perceived implementation of the ten dialogic practices in the classroom. The data indicates a positive monotonic relationship between years of teaching experience and the perceived frequency of dialogic practices implemented in the classroom. Notably, dialogic moves 2, 5, 6, and 7 demonstrate a particularly strong correlation. Additionally, it is important to highlight that only four of the dialogic practices (DP2, DP5, DP6, and DP7) were found to be statistically significant.

DISCUSSION

Dialogic Practices in the Classroom

Senior high school STEM students perceive dialogic practices as being implemented with great frequency in their classrooms, with little variation across the different practices. In particular, the highest mean scores from both the teachers' and the students' responses was reported for the dialogic practice 'Connect'. According to the analytical framework by Hennessy et al. (2021), 'Connect' involves dialogic moves that relate students' ideas to prior contributions, observations, lessons, and activities, as well as linking students' ideas to their personal experiences. This practice fosters connections between new knowledge and existing cognitive structures, which is crucial for the retention and reinforcement of learning. By integrating abstract concepts with real-life applications, students can better retain scientific knowledge and develop scientific literacy (Anwar et al., 2022; Dewi et al., 2021). For practitioners, this suggests that continuing to prioritize 'Connect' in the classroom may yield benefits in fostering deeper cognitive connections and more meaningful student engagement with STEM content.

The teachers' assessment of how dialogic practices are positioned in their classrooms paint a slightly different picture. For instance, the lowest mean score reported (M = 6.86) from the entire dataset can be found on the teacher's responses, and falls under the fifth dialogic practice: 'Make Reasoning Explicit'. This dialogic move highlights the importance of prompting students to critique and evaluate on their classmates' arguments or position through explicit reasoning. The lower frequency of this practice, as reported by teachers, aligns with the challenges identified in previous studies regarding the facilitation of scientific argumentation in classrooms (Mikeska & Howell, 2020; Chen et al., 2019; McNeill & Knight, 2013; Sampson & Blanchard, 2012). Teachers often encounter difficulties in prompting students to engage in constructive scientific argumentation, which requires a nuanced understanding of argument structure and the ability to elicit critical discourse from students. This struggle may hinder the effective implementation of reasoning-based dialogic practices, thereby influencing the frequency with which they are employed in the classroom.

Teachers could benefit from professional development opportunities focused on fostering argumentation skills and structuring classroom dialogues that encourage critical discourse. Workshops and training sessions could provide teachers with specific strategies and techniques to promote student reasoning, such as using scaffolding methods to guide discussions or incorporating structured activities that challenge students to evaluate, defend, and critique ideas. Moreover, teachers may need additional resources, such as argumentation frameworks or example lesson plans that integrate reasoning explicitly within the curriculum.

Differences on the Students' and Teachers' Perception of Dialogic Practices

In general, students reported a more positive perception of the ten dialogic practices compared to teachers. This finding is akin to a study by Böheim et al. (2021), which found that students rated the frequency of dialogic moves higher than their teachers, suggesting a discrepancy in perceptions between the two groups. This discrepancy suggests that students may perceive a greater degree of engagement with dialogic practices than teachers report, possibly due to differences in perspective. For instance, students may be more attuned to the interactive aspects of their learning experiences, whereas teachers may have a more critical or reflective view of how frequently and effectively these practices are implemented. A study by Nystrand et al. (2003) supports this notion, highlighting that students and teachers may have differing perspectives on classroom discourse. In line with this, teachers often evaluate their teaching based on their intentions and instructional goals, whereas students perceive dialogue through their lived experience, which may be influenced by factors such as engagement, clarity, and the personal relevance of the dialogue (Tippett, 2016). Students may rate dialogic practices higher due to their increased attention to affective and relational aspects of classroom discourse, such as feeling heard or valued, which may not always align with teachers' assessments focused on pedagogical effectiveness (Mercer et al., 2019).

The significant differences found in these specific items highlight particular areas where there is a divergence in perception. For 'Invite Others to Build on Ideas' and 'Build on Ideas,' the higher student ratings may reflect a more dynamic and inclusive classroom environment where students actively build on one another's contributions. In contrast, teachers may perceive these practices as less prevalent, possibly due to challenges in fostering sustained dialogue among students. This aligns with findings by Firetto and others (2023), who noted that while small-group discussions are effective in promoting student learning in STEM classrooms, various factors, including teachers' perceived ability to facilitate discussions, influence their implementation.

Similarly, the significant difference for 'Make Reasoning Explicit' suggests that teachers may be less confident in their ability to guide students in articulating and evaluating their reasoning. This is consistent with previous studies that point to difficulties in promoting critical reasoning and argumentation within the classroom (Wess et al., 2023). Lastly, the disparity for 'Challenge' could indicate that while students may feel encouraged to challenge ideas and engage in critical discourse, teachers may struggle to facilitate these discussions or may not view them as occurring frequently in the classroom. Another perspective to consider is whether the students overestimate the presence of dialogic interactions in the classrooms, which may be attributed to the study's reliance on self-reported data.

Correlation of Teachers' Teaching Experience and Dialogic Practices

The observed high correlation between teachers' years of teaching experience and the frequency of dialogic practices in the classroom suggests that increased experience enhances the implementation of dialogic moves. This finding aligns with research emphasizing the importance of time in developing and strengthening classroom discourse. As teachers gain experience, they become more adept at fostering interactive learning environments, allowing for the establishment and organic maintenance of 'talk moves'—structured conversational techniques that promote student engagement and critical thinking. To bolster this claim, a study by Alexander (2020) highlights that experienced teachers are more proficient in creating dialogic spaces where students actively participate and build upon each other's ideas. Similarly, research by Mortimer and Scott (2003) underscores that seasoned educators are better equipped to facilitate classroom discussions that encourage students to articulate and evaluate their reasoning, thereby promoting a more dynamic and inclusive learning environment.

For practice, this finding highlights the importance of experience in shaping effective teaching strategies, particularly in the context of dialogic teaching. Teachers with more experience are likely to possess the nuanced skills required to promote thoughtful student discourse and argumentation. This underscores the need for continuous professional development programs that provide opportunities for teachers to refine their dialogic practices, regardless of their years in the profession. Furthermore, the study suggests that new or less experienced teachers could benefit from mentorship programs or collaborative learning communities that allow them to observe and learn from more experienced educators.

CONCLUSION

The findings of this study highlight the importance of dialogic practices in fostering interactive and student-centered learning in senior high school STEM classrooms. Students generally perceived these practices as frequently implemented, with 'Connect' receiving the highest mean score and 'Challenge' the lowest. However, a significant discrepancy emerged between students' and teachers' perceptions, as students consistently reported higher frequencies of dialogic moves than teachers. This gap may reflect differences in perspective, with students focusing on the interactive aspects of classroom activities and teachers critically evaluating the depth and quality of implementation. Teachers may also face challenges in facilitating critical reasoning and argumentation, particularly for practices such as 'Challenge' and 'Make Reasoning Explicit,' suggesting a need for targeted professional development to address these areas. Additionally, the positive correlation between teaching experience and the perceived frequency of dialogic practices indicates that experienced teachers are better equipped to foster meaningful dialogue, likely due to their refined strategies and deeper understanding of classroom dynamics.

Furthermore, given the study's context within the Philippines, where a growing emphasis on STEM education is evident, there is a clear need for policies that emphasize the importance of dialogic pedagogy in fostering scientific literacy. Educational reforms should aim to revise curricula to encourage more interactive, inquiry-based learning that aligns with the goals of the K-12 curriculum framework in the Philippines. For example, the curriculum could be redesigned to integrate specific dialogic strategies that encourage students to critically engage with scientific concepts, promote evidence-based reasoning, and facilitate constructive debates on real-world scientific issues. In similar educational contexts, especially in countries with emerging STEM education priorities, these findings suggest that embedding dialogic practices into national science curricula could enhance the quality of STEM education. Additionally, integrating dialogic practices into teacher evaluation systems could serve as a metric for assessing teaching effectiveness, thus ensuring that teachers are not only knowledgeable in their subject matter but also proficient in fostering dynamic, student-centered discussions. Policies could also promote collaborative teaching environments where experienced teachers mentor their less experienced colleagues, sharing best practices for incorporating dialogic techniques into their lessons.

Despite this, it is important to note that the generalizability of the findings is limited by the study's focus on a single academic institution. While the results provide valuable insights into dialogic practices within this specific setting, the extent to which these findings can be applied to other schools or educational contexts is limited. The institution's unique characteristics—such as its teaching culture, student population, and curriculum design—may not be representative of those in other schools. As such, further research across a broader range of schools or educational systems is necessary to enhance the generalizability and applicability of the results.

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