

Science Classroom Sensemaking Moments Model For Proficient Science Teachers

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ABSTRACT

This study aimed to explore how proficient science teachers facilitate sensemaking moments in the classroom. Specifically, the study sought to describe how science teachers facilitate sensemaking during lesson discussions, exploring the factors that influence their facilitation, and developing a model that will guide proficient science teachers in facilitating sensemaking moments. The study used a case study approach, gathering data from interviews and audio recordings of science classes. Results showed that successful facilitation of sensemaking during lesson discussions includes several steps: Creating of thought-provoking query, elaborating on hypotheses, supporting hypotheses, providing space for reflection, and engaging in a reconciliation process. The cases presented in the study highlighted the effectiveness of collaborative and open teaching methods in facilitating sensemaking. Factors contributing to successful sensemaking included the teachers' facilitation, interactions in the learning environment, teaching approaches, questioning techniques, time constraints, and the classroom environment. These steps and factors were integrated into the proposed sensemaking moments model. Unlike existing frameworks on sensemaking, the proposed sensemaking moments model is grounded in classroom-based cases of proficient science teachers in the Philippine context. Examining sensemaking moments could provide a more comprehensive understanding of how to optimize teaching practices and create sensemaking opportunities for all students in the science classes.

KEY WORDS: Argumentation, science discourse, science secondary teachers, sensemaking, sensemaking moments model

INTRODUCTION

The field of education is constantly evolving, and one of its most pressing issues is how to create effective learning environments for students. However, science education poses a serious challenge for many low and middle-income countries. According to the Programme for International Student Assessment (PISA) 2018 assessment findings, a disparity in science proficiency is observed among 15-year-old students across countries, wherein only 78% of students achieve Level 2 or higher. The proficiency level in science is described as the ability to recognize correct explanations for familiar scientific phenomena and to use that knowledge to determine the validity of conclusions based on provided data. To effectively address the issue, it is crucial to prioritize providing sufficient resources and support to underperforming schools (Schleicher, 2019). Given this, it is reasonable to shift focus to enabling students to construct meaning and make sense of the world around them, or, in other words, sensemaking.

Sensemaking is a complex process that involves utilizing various resources to gain a deeper understanding of the world, including argumentation practices, embodied imagining, everyday experiences, and informal language (Schwarz et al., 2021). When students engage in sensemaking, they grapple with ideas, language, experiences, and perspectives to gain insights through scientific knowledge. Researchers' perspectives on sensemaking vary, ranging from collaborative construction

of claims and explanations through argumentation to a cognitive process that involves integrating new knowledge into existing frameworks (Berland and Reiser, 2009). Put simply, sensemaking is a dynamic process of building or revising an explanation to “figure something out” (Odden and Russ, 2019).

This paper is inclined to refer to sensemaking as the process by which students encounter gaps in their knowledge about a particular scientific phenomenon that is introduced, discussed, or asked by the teacher during a science lesson discussion. These gaps, termed “sensemaking gaps”, serve as queries that need to be answered for a student to understand or make sense of a scientific situation or activity (Weinberg et al., 2014). It can be an intriguing or thought-provoking question. This engagement with the content prompts allows students to engage in argumentation, as they strive to construct explanations that bridge these gaps (Solis, 2022; Weinberg et al., 2014).

Facilitation of sensemaking moments in the classroom is an essential aspect of teaching, as it allows students to develop science knowledge and skills (Davis et al., 2017; Haverly et al., 2020). These moments represent cohesive units of interaction between teachers and students, where they collaborate to comprehend ideas, phenomena, or data. During these interactions, the teacher, who is often considered the primary source of information, shares their epistemic authority with the students, thereby promoting an engaging learning environment (Haverly et al., 2020; Schwarz et al., 2021).

The importance of sensemaking moments in the classroom has been recognized for some time as this allows the development of epistemic knowledge, the thinking about knowing, which, according to the PISA framework, is one of the three domains in scientific literacy. The absence of sensemaking conversations in science classrooms suggests that students may not be receiving adequate guidance from their teachers, who may not have been sufficiently prepared to facilitate such learning opportunities (Benedict-Chambers et al., 2017; Haverly et al., 2020). The reasons for this are not well understood, but research suggests that specific teacher characteristics play a role (Fitzgerald and Palincsar, 2019a).

To address such concerns, this article proposed a model to guide teachers in better sensemaking moments facilitation. The model is derived from a detailed account of how proficient science teachers facilitate sensemaking moments within the classroom while examining the various factors that influence the effectiveness of sensemaking facilitation. This model is a context-specific extension from Schwarz et al. (2021), which was initially used for analyzing sensemaking moments and episodes. The current model, however, is specifically tailored as an instructional guide, providing practical steps and considerations for teachers aiming to foster sensemaking in their classrooms. By focusing on instructional application, the model addresses the contextual needs of science educators, offering strategies grounded in classroom-based practices.

Through this contribution, the article seeks to offer relevant information that can assist science teachers and those involved in teacher-training programs. The goal is to enhance student learning experience and support broader improvements within the educational system. The insights and model presented are intended to serve as valuable resources for educators striving to create meaningful sensemaking opportunities and improve overall educational outcomes.

LITERATURE REVIEW

Over time, the role of teachers in the classroom has transformed from simply disseminating knowledge to that of a learning facilitator. Nowadays, the focus is on empowering students to construct their own understanding and develop a meaningful comprehension of the world. As a result, when facilitating discussions, the teacher must manage the uncertainty that arises from sensemaking about complex scientific ideas by engaging with students' ideas both individually and collectively.

In line with this, facilitation of sensemaking moments in the classroom is an important aspect of teaching, as it allows students to develop knowledge and skills (Davis et al., 2017; Haverly et al., 2020). Sensemaking moments are instances when students are challenged to comprehend new information or solve problems using their existing knowledge (Fitzgerald and Palincsar, 2019; Schwarz et al., 2021). However, teachers vary in their ability to facilitate sensemaking, with some creating opportunities and others unintentionally limiting them (Haverly et al., 2020). The lack of sensemaking discussions

in science classrooms may suggest that teachers are not sufficiently prepared for this work (Haverly et al., 2020; Benedict-Chambers et al., 2017a; Crowhurst and Cornish, 2020; Schwarz et al., 2021). Therefore, by analyzing the relationship between teacher characteristics, sensemaking facilitation, and student engagement, we can better understand the underlying mechanisms that drive effective teaching practices and optimize teaching methods to enhance student learning experiences.

On Science Sensemaking

The sensemaking process in natural science shares a close relationship with sensemaking in general. In contemporary discussions among philosophers of science, it is recognized that the observer's prior knowledge, perspective, and approach to investigating the subject can significantly influence what is observed and understood (Fitzgerald and Palincsar, 2019a). Building on this idea, students can ask and answer scientific questions, learning both scientific content and ways of understanding the world (Calabrese Barton and Tan, 2018). However, if content and practices are separated, students may resort to memorization of isolated facts. To make sense of scientific phenomena and develop scientific thinking, it is crucial to integrate both content and practices. One way to achieve this is through sensemaking discussions, where teachers and students use scientific practices together to understand better scientific concepts (Calabrese Barton and Tan, 2018).

On Teacher's Facilitation of Sensemaking Moments

Not having valuable sensemaking discussions in science classrooms limits valuable learning opportunities for students to develop scientific literacy (Crowhurst and Cornish, 2020; Schwarz et al., 2021; Wallen and Tormey, 2019). Teachers differ in their ability to create such opportunities (Haverly et al., 2020).

Haverly et al., (2020) revealed that for students to have equal opportunities to make sense of scientific concepts, they must be acknowledged and responded to in a manner that acknowledges their epistemic authority. The term "epistemic authority" pertains to whose knowledge and thought processes are considered as experts in the science classroom (Engle et al., 2014). Novice teachers often did so through improvisational moves such as "try-and-see" and "wait-and-see", which created opportunities but often lacked depth.

In contrast, Schwarz et al. (2021) stressed the crucial role of teachers in creating opportunities for sensemaking in science classrooms by inviting students' ideas, exploring new directions, and addressing tensions between science teaching and institutional norms. Fitzgerald and Palincsar (2019b) likewise identified questioning, making connections among ideas, increasing challenge, and differentiating instruction as central to student sensemaking.

Earlier studies, such as Benedict-Chambers et al. (2017b), focused on questioning sequences that supported the

explanation-building, while more recent international research highlights the need to situate facilitation with broader systems of teacher learning and discourse. For instance, Lowell et al. (2021) showed how curriculum design and implementation can oversimplify sensemaking, underscoring the importance of teacher agency. Parsons (2021) highlighted collaboration as central to knowledge co-construction across cultural contexts. Reeve and Cheon (2021) demonstrated that autonomy-supportive teaching enhances student engagement and motivation.

While previous studies have explored teaching strategies and pedagogical approaches, limited research exists on the impact of teacher characteristics on their ability to facilitate sensemaking moments. Understanding the relationship between teacher characteristics and sensemaking facilitation is crucial for enhancing science education and student learning outcomes. This study addresses this gap by focusing on proficient teachers in the Philippine context, providing insights that are useful for local classrooms while also adding knowledge to the wider international conversation on teacher learning and science discourse.

METHODOLOGY

This research used an exploratory case study design to examine sensemaking moments during lesson discussions. It conducted interviews and audio-recorded science classes to gather qualitative data. Based on the study's findings, the researchers developed a sensemaking moments facilitation model for science teachers. This approach offers a comprehensive understanding of the research problem and allows the researchers to cross-validate the findings through triangulation, thereby enhancing the overall validity and reliability of the study.

Participants

The participants of the study are secondary science teachers at different stages of their careers. They are currently teaching in a high school department of a university in Iligan City during the school year (S.Y.) 2022–2023. The teachers received invitations and consent forms. The researchers selected 12 participants using a purposive sampling technique. From this, only eight teachers agreed to participate, representing various expertise and experience levels.

Pseudonyms were assigned to the participants to protect their identities. The group comprised four proficient teachers (T4, T6, T7, and T8) with 1–5 years of teaching experience. In addition, two highly proficient teachers (T1 and T5) with 18–20 years of teaching experience and two distinguished teachers (T2 and T3) with 30 or more years of teaching experience were included. Of the eight science teachers, seven hold master's degrees, and one holds a doctorate. However, only two of them were able to facilitate sensemaking moments successfully, and both belonged to the proficient category. According to the Philippine Professional Standards for Teachers, proficient teachers are knowledgeable with the content, demonstrate a

high level of pedagogical competence, adapt to diverse student needs, foster a positive and inclusive learning environment, and continuously engage in professional development to enhance their practice. By focusing on the proficient teachers, their facilitation practices became the foundation of the proposed sensemaking moments model.

Research Instruments

Semi-structured interview questionnaire

We used a semi-structured interview questionnaire, which was face validated by five educators and experts. Validators' comments and ratings were used to improve the questionnaire. All eight items in the questionnaire received high ratings and were considered relevant and appropriate by the expert panel. The questions aimed to gather insights into the teachers' instructional approach, lesson objectives, resources used, and student engagement strategies. Follow-up questions about interpreting students' contributions and responding to their queries were asked. The questions were asked of all eight teacher participants to ensure a comprehensive exploration of perspectives and practices. We used the identified audio segments containing sensemaking moments as a reference for conducting teacher interviews. We conducted semi-structured interviews following established guidelines, which lasted 30 min to an hour.

DepEd classroom observation tool (COT)

The instrument assesses teachers' level of proficiency in instruction, which teachers must assess personally. The assessment covers 21 classroom observable strands from the Philippine professional standards for teachers. Participants have a week to complete the self-assessment forms. The Philippines' Department of Education utilizes the tool nationwide for observing teachers during their instruction.

Data Gathering Procedure

First, we sought the approval of the school principal and Science department chairperson to gather data from their school and their teachers. We then sought consent from participating science teachers, informing them that we intend to audio-record their classroom discussions and conduct interviews with them. We then asked the teachers to assess their level of proficiency using the DepEd COT. Twenty-one science lessons were recorded using audio recorders. We avoided video cameras at the request of participating teachers. We obtained the recordings and carefully examined the recorded science lesson discussions for audio quality. We then transcribed the recordings and identified moments where students were engaged in sensemaking. The discussions were about 45–60 min long, capturing significant classroom interaction. However, specific interactions, such as jokes, storytelling, instructions, and experiments, were excluded from the analysis. This narrowed down the data to focus on segments with clear sensemaking exchanges. We created electronic portfolios for each participating science teacher containing recorded lesson discussions, transcriptions, translations, and preliminary analyses of sensemaking moments. The teachers

reviewed the audio recordings and the transcriptions for accuracy and approved the identified sensemaking moments. We then conducted interviews with the teachers using the semi-structured questionnaire.

Data Analysis

Thematic analysis

We employed qualitative data thematic analysis technique to identify common themes and patterns in the audio-recorded lessons and the semi-structured interviews with teachers as proposed by Braun and Clarke (2006). We first identified sensemaking moments in the recorded science lessons, utilizing the Sensemaking Moments model by Schwarz et al. (2021) as a framework for analysis. We also transcribed the teacher interviews and developed codes. One author carried out the initial coding, then the research team audited, and finally verified by participating teachers. We repeatedly listened to the recordings and read the transcripts, noting terms or phrases expressing the same idea. We then analyzed the created codes and organized them into themes. Finally, the developed themes were defined based on the acquired data from the semi-structured teacher interviews.

Cross-case analysis

We employed cross-case analysis to compare data from different teacher cases, aiming to identify similarities and differences in the factors affecting sensemaking facilitation. The data collected from each case were systematically analyzed to identify common patterns and variations across the cases.

FINDINGS

Science Teachers' Sensemaking Facilitation

Case 1: Thoughtful approach in fostering sensemaking moment of teacher A

Teacher A is a male with 3 years of teaching experience in high school and holds a master's degree. He specializes in teaching physics to grade 9 students and earth science to grade 10 students. He credits one of his past instructors for influencing his teaching methods in science classrooms.

Teacher A began a lesson on Surface and Deep Ocean Currents by showing a map of global ocean currents. Students were encouraged to share their observations. The teacher discussed heat flow and patterns of ocean currents, prompting students to use their knowledge of specific heat. To promote critical thinking, a hypothetical scenario was presented: If ocean currents' circulation becomes non-existent, what do you think would be their effects on Earth, as well as its inhabitants? SA, a student, was selected to respond to this question, leading to a subsequent discussion and several notable instances of sensemaking throughout their dialog.

In the beginning of the discussion, Teacher A encouraged Student A to articulate her hypothesis and probed further to refine her ideas, demonstrating a thoughtful approach to fostering sensemaking.

In Table 1, lines L1–L11, Student A explains her hypothesis based on her understanding of density. Teacher A seized this opportunity to enhance and clarify her hypothesis by guiding her towards connecting density, temperature regulation, and their roles in ocean current circulation (L12–15). He acknowledges Student A's hypothesis and concludes the discussion by sharing his expected answer to the posed gap. According to him, if the circulation was to cease abruptly, abnormal seasons would occur worldwide, causing suffering among its inhabitants.

In Figure 1, the inquiry of Teacher A into the initial answer of SA's created an opportunity for SA to engage in sensemaking. Using probing strategies, Teacher A encouraged a collaborative environment where both teacher and student shared authority in knowledge construction. This facilitation allowed SA to contribute actively, drawing on her observations and prior knowledge to support her hypothesis. This co-constructed facilitation of epistemic authority provided valuable insights into SA's perspective, leading to a clearer understanding of

Table 1: Sensemaking facilitation of teacher A

Line Code	Speaker code	Transcript of teacher-student exchange
L1	SA:	If ocean currents become non-existent, the temperature will likely lose its stability if it stops circulating.
L2	TA:	What was it again? The temperature will...?
L3	SA:	[The temperature] will lose its stability.
L4	TA:	The temperature will lose its stability? What do you mean by that?
L5	SA:	It will no longer circulate because there will be colder places.
L6	TA:	There are places that...?
L7	SA:	...are colder.
L8	TA:	Some places are colder, and there are also places that.?
L9	SA:	...are hotter. Therefore, the icebergs will no longer melt in those colder places. They will not change. Their density will not change.
L10	TA:	That's true. There are indeed cold and hot places . (unfinished because SA interrupted)
L11	SA:	Therefore, the icebergs will no longer melt in those frigid regions, and their density will remain constant.
L12	TA:	The density will not change, and then? What will that do with our question? If the density will not change? Okay, to guide you with the question, what is the role of circulation in the current? What benefits arise from its circulation?
L13	SA:	It will balance and regulate temperature.
L14	TA:	That is right. So, imagine that did not exist, what would happen then? What will be its effect on Earth?
L15	SA:	(SA did not answer)
L16	TA:	You are actually very close to the right answer. You just need to construct your sentence well. Refer to your first answer where you mentioned that there are cold places and so on, as that is a reality existing now.
L17	SA:	Places that are currently cold will no longer experience as much heat, so they will remain cold.
L20	TA:	So, that's it. Thank you.

Legend: TA: Teacher A; SA: Student A

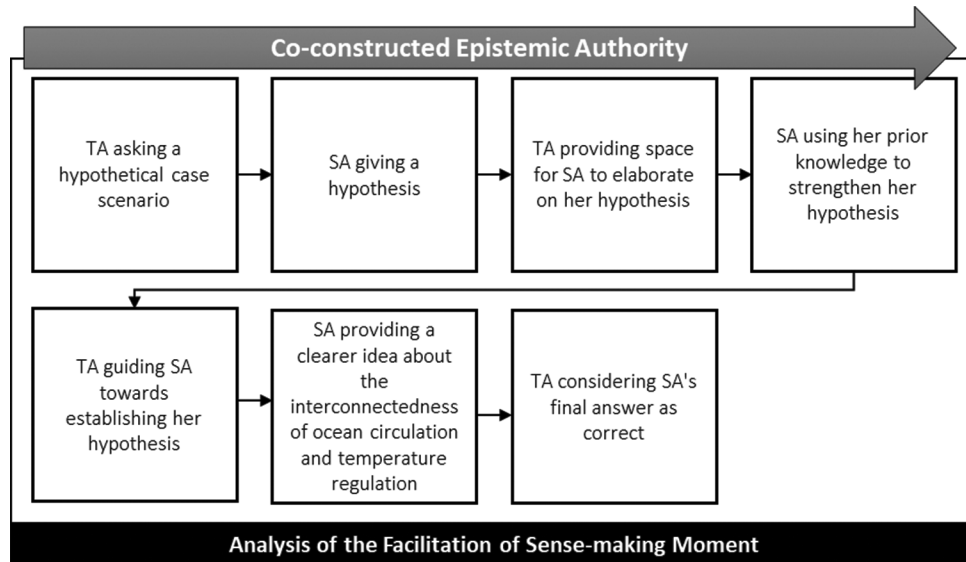


Figure 1: Sensemaking moment facilitation process of teacher A

the topic. This highlights the importance of collaborative sensemaking and the role of teachers in empowering students to contribute to knowledge construction (Gutierrez, 2019).

Case 2: Open teaching approach in collective sensemaking of teacher B

Teacher B is an experienced physics teacher with a master's degree and 18 years of teaching experience. She is responsible for three class sections and aims to instill a genuine passion for physics in her students. The study captured one sensemaking moment from Teacher B's session, as the other session was hindered by external factors like heavy rain causing noise interference. Teacher B approved the included moment.

During the discussion on the properties of light, Teacher B explored the concept of dispersion and highlighted its connection to refraction, different indexes of refraction, and varying frequencies of light. The topic prompted Teacher B to explain how rainbows are formed as a manifestation of dispersion. Teacher B initiated the explanation: "When you look at a rainbow, it is your personal rainbow. You think you are looking at the same rainbow, but you are not." However, this discussion took an intriguing turn when student B posed a question that sparked a thought-provoking and engaging discussion within the class.

Within the discourse in Table 2, a notable sensemaking moment unfolds as student B raises a thought-provoking gap regarding the concept of a personal rainbow, as previously shared by Teacher B. Student B's inquiry prompts a lively and active communication where all students are given equal opportunity to express their claims on why the same rainbow appears in a picture despite each individual experiencing it as a personal phenomenon. This sensemaking moment sparks a collective exploration of the scientific phenomenon, where students are given space to present their statements with the strength of their claim and openly accept critiques of claims. This approach

led to a collective exploration of the question at hand (Adair et al., 2015). While the conversation did not yield a definitive conclusion, both the teacher and students agreed to experiment with the problem. They recognized that their observations might be affected by the limitations of human senses.

By adopting an open teaching approach, Figure 2 shows that Teacher B opened the floor to provide equal opportunities for all students to express their hypotheses, offer critiques, and respond to questions. This open environment fostered a sense of epistemic authority for Student B, allowing her hypothesis to become a catalyst for a rich exchange of ideas within the science classroom. This case exemplifies the importance of creating spaces where students can actively engage in collaborative sensemaking, thereby promoting more profound understanding of the construction of knowledge.

Factors That Affect Teacher's Facilitation of Sensemaking

The importance of creating collaborative environments for students to contribute, engage in sensemaking, and construct knowledge is highlighted in both cases. Teachers play a vital role in promoting more profound understanding and facilitating learning by fostering such environments. Thematic analysis of the classroom observations and teacher interviews revealed several aspects in the two cases that influence teachers' facilitation of sensemaking moments.

Classroom climate and student engagement

The teachers recognize the impact of the environment on student engagement. They suggested that a positive and supportive classroom atmosphere can encourage students to actively participate, ask questions, and engage in discussions, fostering a sense of curiosity and critical thinking. On the other hand, a lack of supportive atmosphere can hinder sensemaking moments by creating disinterest, disengagement, and limited opportunities for students to process and make sense of the phenomenon being presented actively (Tas et al., 2019). These

Table 2: Sensemaking facilitation of teacher B

Line code	Speaker code	Transcript of teacher-student exchange
L1	SB	Ma'am, you mentioned that the rainbow we see is unique. However, why is it that when we take a picture of it, it looks the same?
L2	TB	Ah, when you take a photo of it
L3		(Students overlapping conversation: You see the same in the camera because that is what the camera sees/ it's the camera's own rainbow Ma'am/because it will process it)
L4	TB	Wait, wait, wait. What I'm really thinking is that it looks the same because what you're showing is not the actual rainbow, but just a picture of it.
L5	SB	Yes, but I can see the rainbow, and wow, it looks the same as in the picture.
L6	TB	Ah okay
L7	SC	It's different because it's a different procedure.
L8	SD	I think that's the cellphone's rainbow, Ma'am
L9		(Students continue to contribute answers simultaneously *inaudible)
L10	TB	So, how are we going to explain that? How can we explain it? The shape of the rainbow is a cone. If we say "that's your personal rainbow", it means that the source of your rainbow comes from different droplets. Do you understand what I mean? It's like when I'm looking at you from one spot, and then I move slightly to another spot, but still look at you from a different angle. So, what makes it different – no, wait, that's not a good analogy. Do you understand what I'm trying to say? Just try to understand me.
L11		(Students gave random, inaudible answers due to overlapping voices)
L12	SE	It's the camera's own set, Ma'am.
L13	TB	Come again?
L14	SE	It's the camera's own set, Ma'am. Like a personal rainbow of the camera
L15	TB	Ah, yeah, maybe. She said it's the camera's personal rainbow (pointing to SE), but we could conduct a test for this. For example, if you're here, it's like you're going to take a picture. You can place different cameras and then take a snapshot of the rainbow simultaneously. Because I feel like there will be slight differences in the results due to different pixels, but I guess you would still get a similar result. However, if you trace it back, you would find that they have different sources
L16	SF	Maybe there will be a little difference...
L17	TB	that we cannot ...
L18	SF	Like identify?
L19	TB	That we can't detect because our senses have limitations, right?
L20		[Students agree by nodding their head gesture and random "woah" answers due to overlapping voices]

TA: Teacher B; SB: Student A; SC: Student C; SE: Student E; SF: Student F

are evident in the two cases. In the first case, the student's initial hypothesis is acknowledged, but the teacher's probing questions prompted her to construct a more comprehensive concept. In the second case, the student's misconception becomes the gap that leads to collaborative sensemaking and

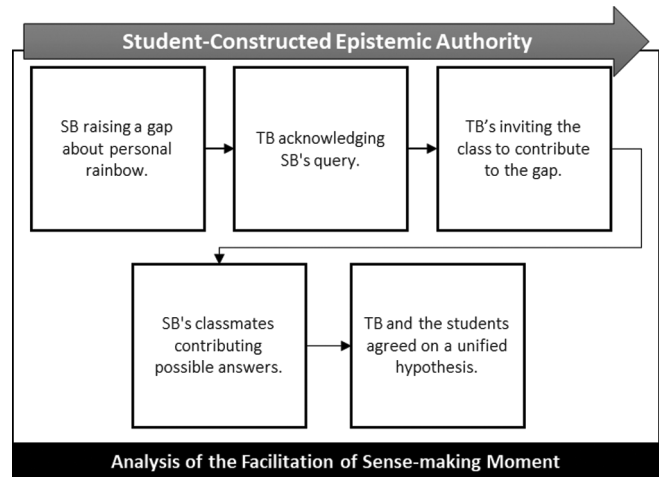


Figure 2: Sensemaking moment facilitation process of teacher B

a deeper understanding of the concept. Therefore, creating an engaging and interactive classroom environment leads to sensemaking moments that allow conceptual development (Srisawasdi and Kroothkeaw, 2014).

Teaching approach

Both cases support the constructivist approach to learning, where learners actively construct their understanding by connecting evidence and reasoning to fill knowledge gaps (Ford, 2012; Koretsky et al., 2018). Teachers A and B in this study create opportunities for students to reflect, draw on prior knowledge, and refine understanding through active participation. Both cases prioritize student-centered learning, valuing individual needs, ideas, and contributions. In these cases, teachers recognize students' perspectives, promote active engagement, and encourage collaboration. This learner-centered approach fosters a more profound understanding and co-construction of knowledge (Lowell et al., 2021; Parsons, 2021).

Questioning and probing technique

The importance of effective questioning and probing techniques that teachers employ is highlighted in these cases. By asking thought-provoking questions and probing for deeper explanations, teachers encourage critical thinking, reasoning articulation, and self-evaluation among students, leading to a more comprehensive understanding (Lowell et al., 2021). In the first case, the teacher's careful questioning and guidance provided feedback to the student, prompting her to reflect on her initial hypothesis and reconcile it with her previous understanding. In the second case, the teacher's open approach encouraged the class to reflect on a classmate's question and contribute their thoughts, promoting metacognition and a deeper understanding of the subject matter (Efklides, 2006; Reingold et al., 2008).

Time

A teacher's ability to explore topics in depth is influenced by the need to allocate sufficient time for practice exercises, which is often restricted by a syllabus and limited teaching hours. Teachers recognize these constraints and understand

the necessity of covering a specific amount of material within a defined timeframe. However, these time limitations can impede opportunities for meaningful understanding, as they restrict students’ chances to dive deeper into subjects, engage in reflective thinking, and fully grasp the complexities of the material (Teig et al., 2019).

The mentioned themes imply that teachers face challenges in fostering sensemaking moments due to time constraints imposed by the syllabus and limited teaching time. Yet, they also highlight the importance of creating engaging and open learning environments that promote critical thinking and empower students as active participants in their learning. The themes also showcase that constructivist teaching is the favored approach for sensemaking that allows students to explore, inquire, and create ideas. The approach also requires teachers to be facilitators and be able to scaffold learning, which, for the two cases, is done through questioning techniques. While these factors - classroom climate and constructivist teaching approach are important for sensemaking, it should be noted that both require teachers’ deep content knowledge to be able to support students in their sensemaking. Such knowledge is inherent in a proficient science teacher

Sensemaking Moments Facilitation Model

The developed sensemaking facilitation model is illustrated in Figure 3. The process starts with either the student or the teacher creating a thought-provoking query. This thought-provoking query serves as the sensemaking gap and can determine whether the sensemaking moment in the lesson discussion is enriched or not. However, the facilitation of this moment depends on how the teacher handles it. Therefore, the broken line arrow indicates the factors that hinder sensemaking moments. In contrast, the bold arrow represents the factors that support the successful facilitation of such moments in science lesson discussions, as it influences the steps involved in the facilitation process.

Next, learners share their hypotheses. If the student initiates the thought-provoking query, the teacher facilitates hypothesis elaboration by constructing a statement or question in response, guiding the student in hypothesis construction. The third step involves supporting their hypothesis by providing

an opportunity for students to offer explanations for their hypothesis or share their ideas or arguments on the scientific phenomenon. This step encourages active participation and the inclusion of diverse perspectives, fostering a collaborative sensemaking process.

The next step is to allow space for students to think, reflect, and process the various hypotheses. This step involves providing time for learners to internalize the different viewpoints presented, promoting independent thinking, giving equal opportunity to express hypotheses and critiques, and enabling students to evaluate the hypotheses while making connections with their prior knowledge (Darling-Hammond et al., 2020; Reeve and Cheon, 2021). In the final step, the students or the class reconciles their ideas. The teacher may provide the correct hypothesis or facilitate a discussion to arrive at the correct explanation. This step ensures that students clearly understand the scientific topic or concept, fostering a thorough comprehension of the subject matter.

Schwarz et al. (2021) examined how elementary teachers move, expand, maintain, or shut down sensemaking. The proposed developed sensemaking moments facilitation model highlights the facilitation phases enacted by proficient secondary science teachers. Each phase of the proposed model was derived directly from the themes identified in Section 4.2. For example, the “thought-provoking query” phase reflects the teachers’ consistent use of challenging questions to surface knowledge gaps. The “hypothesis elaboration and support” phases emerged from patterns where teachers guided students to articulate and justify their ideas. The “reflection space” phase aligns with observed pauses where teachers deliberately allowed students to process and respond, while the “reconciliation” phase reflects moments when students refined or revised their explanations in light of new input. By grounding the model in these observed practices, we ensure its validity as a product of empirical classroom data.

By implementing this model, proficient science teachers can enhance their instructional practices and improve their ability to support student understanding. However, it is essential to note that not all proficient science teachers can effectively foster these moments, as various factors can hinder their

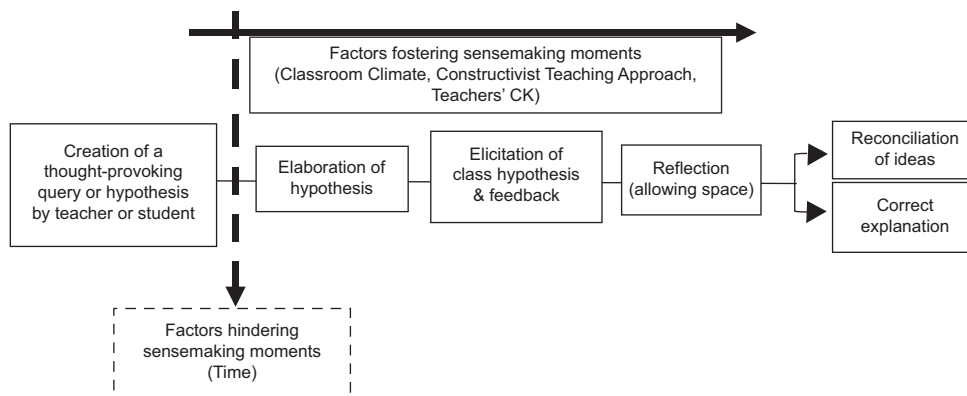


Figure 3: Sensemaking moments facilitation model

facilitation. Therefore, future research should further explore the barriers and challenges that proficient science teachers face in this area. In addition, successful facilitation of sensemaking moments can help students arrive at correct explanations of scientific phenomena, ultimately engaging them in further investigations and encouraging the transfer of their knowledge to new contexts.

DISCUSSION AND CONCLUSION

There are several lessons that can be learned from this study. First, a favorable classroom climate is essential for successful sensemaking. Such an atmosphere enables students to actively engage in the content and feel comfortable inquiring, creating, and sharing ideas. Second, deliberate preparation is vital. Effective facilitation does not happen by chance; it requires intentional planning by the teachers, just like the case for the two teachers. Sensemaking is not recommended for all topics; hence, teachers need to thoroughly map out the curriculum and identify specific topics that are suitable for sensemaking. Third, the role of strong content knowledge is crucial for teachers to guide classroom discussions. Content knowledge allows teachers to address misconceptions, sustain inquiry, and facilitate richer understanding of scientific phenomena. Fourth, teaching proficiency does not guarantee successful facilitation, thus the need for reflection and professional development.

Beyond describing teacher practices, the cases described in this study demonstrate how proficient teachers actively contribute to the ongoing theorization of sensemaking by offering practical instructional guidance that extends the work of Schwarz et al. (2021), who highlighted the impact of specific teacher moves on sensemaking. Our developed sensemaking facilitation model not only complements existing analytical frameworks but also provides a straightforward, practice-oriented approach for facilitating sensemaking in classrooms. It encompasses key phases such as creating thought-provoking queries, elaborating on and eliciting hypotheses, supporting explanations, providing reflection space, and reconciling student ideas. While drawing from previous research, the model refines these elements by emphasizing the central importance of probing strategies and collaborative reflection, striking a deliberate balance between teacher guidance and student autonomy. By implementing this model, teachers – whether in pre-service training or ongoing professional development – can practice and strengthen skills in questioning, probing, and guiding reflective discussions, ultimately creating and sustaining meaningful sensemaking opportunities for students and serving as a valuable resource for teacher education and training.

LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

This study is limited in several ways. First, the small sample size ($n = 8$) limits the breadth of perspectives represented and calls for caution in generalizing the findings. Second, data collection relied on audio recordings which limit our chance to

analyze non-verbal cues such as gestures or facial expressions. Third, the use of DepEd COT to identify teacher proficiency level, through self-report may have inherent biases. These limitations should be considered when interpreting the findings, and future research could address them using larger samples, incorporating video data, and employing varied measures for teacher proficiency.

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ETHICAL CONSIDERATION

We ensured that ethical considerations were met in this case study by obtaining approval from the College of Education, Mindanao State University-Iligan Institute of Technology ethics committee. In addition, we prioritized participant confidentiality and anonymity. For this purpose, we assigned coded labels to the individuals involved in the study, and we consistently used these labels throughout the research process to ensure confidentiality. Furthermore, we obtained informed consent from each participant before recording their lessons and conducting interviews. We also informed the participants of their right to withdraw from the study at any time. Then, we diligently report the findings respectfully and accurately. The study aims to inform best practices in science teaching, rather than unfairly critiquing or undermining individual teachers.

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