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Teachers' practices, challenges, and opportunities in developing science literacy among high school students

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Abstract: This research aimed to explore the experiences of high school science teachers, focusing on their perceived practices, challenges, and opportunities in fostering science literacy among students in the Talon-Talon District, Division of Zamboanga City. A mixed-methods approach was employed, integrating both qualitative and quantitative research designs. The quantitative component involved administering a structured survey to a broad sample of science teachers, while the qualitative component involved conducting in-depth key informant interviews. The data was analyzed using descriptive statistics and thematic analysis. The findings revealed that teachers perceive their practices in developing science teaching literacy as a complex process that involves a deep understanding of science content, the use of effective pedagogical strategies, and the promotion of actual and post-literacy skills. They face challenges in addressing diverse student needs and fostering creativity and critical thinking. However, opportunities exist in continuous professional development, innovative teaching methods, and promoting higher-order thinking skills. The study provides valuable insights into science teachers' experiences in fostering scientific literacy. The findings could assist in overcoming the challenges faced in teaching and developing science literacy, thereby aiding in the successful integration of science literacy in the curriculum and teaching. Based on the findings of the study, several recommendations can be made for science teachers, students, school administrators, the Department of Education, and future researchers. These recommendations aim to enhance the teaching and development of science literacy, improve teaching methods, guide the formulation of policies and guidelines related to science literacy, and serve as a basis for future studies.

Keywords: Scientific Literacy, Science Teachers, Mixed-method approach, Teaching Practices, Professional Development

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INTRODUCTION

In response to rapid technological advancements, the education sector is evolving to prepare students for the future. This approach, known as Education 4.0, emphasizes equipping students with essential skills through innovative teaching methods. The Philippines, through its K-12 curriculum, is actively addressing this shift. However, ongoing evaluations highlight the need for further refinement to ensure effective preparation for an increasingly interconnected and technology-driven world (OECD 2022).

Despite consistent efforts to improve educational outcomes, the Philippines continues to face concerning trends in science education, as revealed by international assessments. While the 2022 PISA results showed a slight improvement in the country's ranking to 77th out of 81 participating countries in mathematics from 78th in 2018, the overall score remained significantly lower than the OECD average (OECD 2022). This stagnation, coupled with the Philippines' continued ranking among the lowest in science literacy in both the 2018 (OECD 2018) and 2019 TIMSS (Mullis et al. 2019) assessments, paints a concerning picture and necessitates a critical examination of the underlying factors contributing to these shortcomings. Further compounding these concerns are the results of the 2018 National Achievement Test (NAT), where Science and Mathematics had the lowest scores with overall mean percentile scores (MPS) of 36.91 and 35.34, respectively, falling far short of the

national standard of an acceptable MPS of 75% (DepEd 2018). These consistently low scores across various assessments, both national and international, highlight a pressing need to investigate the factors contributing to these shortcomings and identify areas for improvement in science literacy in the Philippines.

In this study, "science literacy" refers to the understanding and application of scientific concepts, as well as the ability to think critically and navigate the world through a scientific lens. While various aspects of the educational system undoubtedly play a role, the crucial role of science teachers in fostering scientific literacy among students cannot be overstated (Baik and Kim 2019). These educators play a pivotal role in shaping students' understanding of scientific concepts, nurturing their curiosity, and equipping them with the necessary skills to think critically and navigate the world through a scientific lens (Abd-El-Khalick 2012).

For this reason, the study aimed to explore the lived experiences of high school science teachers in the Philippines, with a focus on their perceived practices, challenges, and opportunities in fostering science literacy among students. It sought to gain deeper insights into the details of science education in the Philippine context. This understanding can then be used to develop effective strategies for empowering science teachers and ultimately improve students' science literacy. This, in turn, can contribute to a brighter future for the Philippines, where individuals are equipped to actively participate in a world increasingly shaped by science and technology, preparing them for a future demanding strong scientific understanding and critical thinking skills not only in the district and schools division but in the country.

The findings of this study could have significant policy implications, providing valuable insights for planning and development in the education sector, particularly in the area of science education.

Statement of the problem

This study intended to explore the perceive practices, challenges and opportunities encountered by science teachers in teaching and developing Science literacy among students.

Specifically, the study sought to answer the following questions:

1. How do teachers perceive their practices in developing Science teaching literacy among students in terms of the study of content, pedagogical strategies, actual literacy, and post-literacy?
2. What are the practices of science teachers in teaching science literacy among students and developing Science literacy among students?
3. What are the challenges encountered by the science teachers in teaching science literacy among students and developing science literacy among students?
4. What are the opportunities encountered by the science teachers in teaching science literacy among students and developing science literacy among students?

LITERATURE REVIEW

Science literacy

Scientific literacy is a specialized form of literacy that enables individuals to navigate a world increasingly influenced by science and technology (National Research Council, 2012). It involves understanding scientific concepts and using science as a tool for informed decision-making (Dillon, 2009). The Department of Education in the Philippines recognizes scientific literacy as the cornerstone of science education, aiming to cultivate informed citizens capable of making science-based decisions (DepEd, Philippines). The Program for International Student Assessment (PISA) defines scientific literacy as the ability to engage with science-related issues as a reflective citizen (PISA, 2015). The National Research Council (2012)

extends the concept of scientific literacy beyond basic reading and writing abilities to include understanding and applying scientific concepts.

Teachers and science literacy

Teaching scientific literacy is complex, requiring a deep understanding of the subject and effective pedagogy (Dani, 2009). The absence of a universally accepted definition of scientific literacy can challenge teachers in translating the concept into classroom practices (Deniz, 2011). Teachers' attitudes and self-efficacy in science play a crucial role in shaping students' attitudes and achievements in scientific literacy (Munck, 2007; Evans & Rennie, 2009). Discipline-specific literacy is necessary for successful content learning (Wu et al., 2018). Teacher support within science classrooms is significant, with a positive teacher-student relationship impacting student motivation, involvement, and academic achievement (Dietrich et al., 2015; Cheema &Kitsantas, 2016).

Fostering science literacy

Challenges and Opportunities. Scientific literacy in students is influenced by various factors including attitudes towards science, socioeconomic status, access to educational resources, and the home learning environment (Karakoc, 2020; Anıl & Özer, 2012). A positive correlation exists between the availability of books, computers, and mobile phones in students' homes and their scientific literacy scores (Kaya & Doğan, 2017). Extracurricular activities and parental education level also play significant roles (Beaton et al., 2016; Karabay, 2012). Gender and sociocultural aspects further impact scientific literacy, emphasizing the need for equitable access to quality science education (Akpınar et al., 2009; Evans & Rennie, 2009).

Science content and pedagogies to fostering science literacy

Scientific literacy in students depends on teachers' content knowledge and pedagogical content knowledge (National Science Teachers Association, 2019). It involves critical thinking skills, fostered through collaborative learning environments (Freire, 1970). The Philippines' Department of Education employs strategies like constructivism, inquiry-based learning, and integrative learning (DepEd K-12 Curriculum). Research suggests the effectiveness of integrating reading skills and home science exploration, along with engaging science topics and research involvement (Glaze, 2018; Kurz, 2018).

Post-literacy and science literacy

Scientific literacy extends beyond classroom instruction, with strategies promoting scientific writing, vocabulary development, diverse learning resources, and independent learning (Owens, 2023; Kesty, 2023). Teachers can encourage students to replace common words with scientific counterparts, broadening vocabulary and cultivating critical thinking (Owens, 2023). Diversifying learning resources beyond textbooks caters to diverse learning styles and bridges the gap between abstract concepts and real-world applications (Kesty, 2023). Encouraging independent learning and synthesis fosters critical thinking and communication skills (National Science Teaching Association, 2023). Science teachers develop science literacy through stages of content study and pedagogical strategies, reflecting the curriculum's emphasis on understanding and applying scientific knowledge.

METHODOLOGY

The study was conducted within the Talon-Talon District, Division of Zamboanga City. The specific institution involved was not named to maintain confidentiality. This locale was chosen due to its diverse population of science teachers, master teachers, and head teachers, providing a rich and varied sample for the study.

The study employed a total enumeration sampling technique, a type of purposive sampling that involves examining the entire population. This method was chosen to ensure that every member of the population had an equal chance of being included in the study. The respondents of this study were science teachers, master teachers, and head teachers from various secondary schools within the Talon-Talon District. These respondents were chosen based on their unique insights and experiences in teaching science literacy among students.

Data was gathered through a structured questionnaire and key informant interviews among the qualified participants. The researcher sought permission from the Schools Division Superintendents and coordinated with the administrators and participants for the scheduling of survey and key informant interview times and venues. This procedure ensured that the data collection process was systematic, organized, and respectful of the participants' time and schedules.

The instrument used was a researcher-made questionnaire and an interview guide. The questionnaire consisted of various items, utilizing a Likert scale. The instrument underwent rigorous pilot-testing and validation to ensure its reliability and validity. This process ensured that the instrument was fit for purpose, accurately measuring the variables of interest, and producing reliable and valid results.

The data collected was subjected to statistical analysis for the quantitative data, and thematic analysis approach for the qualitative data. The quantitative data included responses from survey questionnaires, while the qualitative data consisted of recorded in-depth interviews. This mixed-method approach to data analysis allowed for a comprehensive understanding of the research questions, providing both breadth and depth of understanding.

The scope of the study was limited to the lived experiences and challenges and opportunities encountered by science teachers in developing Science teaching literacy among students. The study was also confined to the Talon-Talon District, Division of Zamboanga City. The study had several limitations, including the sample size and the number of participants, the availability of local related studies, and the voluntary nature of participation in the study. These limitations were acknowledged and considered throughout the research process, and efforts were made to mitigate their impact on the study's findings.

This comprehensive methodology ensured a thorough and rigorous exploration of the research questions, providing valuable insights into the experiences, challenges, and opportunities encountered by science teachers in teaching and developing science literacy among students. It also laid the groundwork for future research in this area, contributing to the ongoing discourse on science education.

FINDINGS AND DISCUSSION

Teachers' perception of their practices in teaching and developing Science literacy among students

Study of content

Science teachers consistently incorporate the study of content in their teaching practices, as evidenced by an overall mean response of 3.52 with a standard deviation of 0.245. The qualitative response was "Highly practiced," suggesting that the majority of teachers

consistently focus on content in their teaching practices. The data distribution was symmetrical, with skewness and kurtosis of -0.8512 and -0.0672 respectively (George and Mallery 2010). This implies that the responses were evenly distributed around the mean, indicating a balanced view among the teachers.

Science teachers' perceptions significantly influence their instructional practices and the comprehensiveness, relevance, and dynamism of their science programs (Takah and Yacoubian 2019). Recognizing the importance of science content and its impact on students' learning experiences is crucial for science teachers. Proficiency in the subject area enables teachers to provide more effective education and involve students in meaningful learning activities. This effectiveness stems from their ability to integrate disparate ideas, confidently answer queries, and provide concise answers (Gardner et al. 2019).

The study's findings reveal a strong inclination towards the collaborative and inquiry-based nature of science, as evidenced by the highest mean score of 3.97 for the statements "Science develops collaborative learning" and "Science develops inquiry among learners". This aligns with a study conducted in the Philippines by Bernardo et al. (2008), which found that students' perceptions of their science classes were significantly influenced by the teacher's pedagogy and the learning environment, particularly those that promoted learner-centered pedagogy, science inquiry activities, and self-learning.

The statement "Science CANNOT provide perfect answers to problems" received the lowest mean score of 2.66, suggesting that the respondents acknowledge the inherent limitations of science and understand that it does not always yield definitive or absolute answers. This understanding is crucial in fostering a realistic view of science, recognizing that while science offers a rigorous and reliable framework for understanding the world around us, it does not claim to provide perfect answers.

Conversely, the overall mean score for the study of content was 3.52, indicating a generally positive and comprehensive understanding of science among the respondents. This finding is corroborated by a systematic review by Nicol et al. (2022), which found that postsecondary school students were most concerned about the impact of laboratory activities and preferred learning engagements that were independent, participatory, and interactive.

Furthermore, the respondents perceived that the study of science content fosters collaborative learning. This aligns with the perspective of Cambridge University, which emphasizes that collaborative learning is a powerful approach that fosters student engagement, academic accomplishment, and the development of essential skills (Dillenbourg 1999). When students work together, they achieve more than they do as individuals. Collaborative learning activities provide students with opportunities to develop crucial skills such as oral communication, leadership, self-management, critical thinking, problem-solving, and creativity. Moreover, working collaboratively helps students form caring, supportive relationships with their peers, leading to enhanced self-esteem and robust social skills (Johnson and Johnson 2009).

Furthermore, the participants acknowledged the importance of a strong foundation in science knowledge. Participant 1, for eample, emphasized the dynamic nature of science, aligning with the view of science as an ever-evolving field requiring continuous learning and adaptation (National Research Council, 2012). This highlights the need for teachers to stay updated with the latest scientific advancements.Participant 2, however, highlighted the importance of moving beyond content delivery. They emphasized the value of inquiry-based learning and collaboration, where students actively engage in asking questions, investigating problems, and developing solutions (Bernard et al., 2008). This approach fosters teamwork and cooperation in scientific exploration, aligning with the constructivist view of learning where knowledge is actively constructed through experiences (Piaget, 1973).

Furthermore, Participant 1's perspective on engaging students with diverse scientific concepts aligns with the constructivist principle of fostering curiosity, critical thinking, and problem-solving skills through active engagement with content (Brooks & Brooks, 1999).
Participant 2 further emphasized the need for teachers to not only possess deep content knowledge but also effectively communicate it to students. This aligns with research highlighting the importance of pedagogical content knowledge, which combines subject matter expertise with the ability to present information in a way that facilitates student learning (Shulman, 1986).
The data collected in this study suggests that teachers perceive the study of content as a cornerstone for developing science teaching literacy among students. This conclusion is supported by two key findings: firstly, the quantitative results revealed a moderate to strong agreement among teachers on the statement "The study of content is essential for effective science teaching," with an average response score of 3.52 (George & Mallery, 2010). This numerical data indicates that teachers generally recognize the importance of possessing a deep understanding of scientific concepts. Secondly, the qualitative data from Participant 1 further strengthens this notion. The participant emphasized the significance of engaging students with diverse scientific concepts as a means to foster curiosity, critical thinking, and problem-solving skills. This highlights the perceived connection between content knowledge and developing these crucial aspects of scientific literacy.

In conclusion, these findings suggest that teachers perceived practices a thorough understanding of scientific content is not just advantageous but fundamental for both effective science teaching and fostering science literacy among students. They likely view the study of content as laying the groundwork upon which students can build their understanding, engage in inquiry, and ultimately develop critical thinking and problem-solving skills. It is important to acknowledge, however, that this study focuses solely on teachers' perceptions, and further research may be necessary to understand how these perceptions translate into actual classroom practices and their impact on student learning outcomes.

Pedagogical strategies

The overall mean response of science teachers regarding their pedagogical strategies in teaching and developing science literacy among students was 3.68 with a standard deviation of 0.408, indicating a high level of consistency in their practices. The data distribution was symmetrical, as evidenced by the skewness and kurtosis values of -1.732 and 2.377 respectively (Byrne 2010; Hair et al. 2010). This symmetry in the data distribution implies that the teachers' perceptions of their practices are balanced and not skewed towards any particular strategy.

When considering the mean rating of 3.68 and a standard deviation of 0.408 (range 3.272 to 4.000), it can be inferred that the vast majority of the teachers perceive their practices as being consistently observed in terms of pedagogical strategies. This suggests a strong commitment among science teachers to employ effective pedagogical strategies in their efforts to teach and develop science literacy among students. The study's findings reveal that the majority of science teachers consistently focus on integrating new information into students' existing knowledge base in their teaching practices, as evidenced by the highest mean score of 3.89 for the statement "I integrate new information into their existing knowledge base". This finding aligns with a study by Nicol et al. (2022), which emphasized the importance of integrating new information with existing knowledge to facilitate deeper understanding and learning.

On the other hand, the statement "Organizing and integrating information during the learning process" received the lowest mean score of 3.40. While this score is still relatively

high, it suggests that there may be room for improvement in how teachers organize and integrate information during the learning process. This finding is consistent with the literature that highlights the importance of effective organization and integration of information in facilitating student learning (Byrne 2010; Hair et al. 2010).

The overall mean score for pedagogical strategies was 3.68, indicating a generally positive perception of these strategies among the respondents. This suggests that the respondents perceive pedagogical strategies as an integral part of science education, contributing to a comprehensive understanding of science. This finding is supported by a review commissioned by the Ministry of Education, which reported on significant international and New Zealand research on effective pedagogy and the links between student learning, curricula, pedagogy, and assessment in science education across the compulsory sector (Hipkins et al. 2002).

Understanding student needs is a key focus, as evidenced by both participants. Participant 1 emphasizes the importance of individualized instruction, tailoring approaches to students' strengths and weaknesses (Rogers, 2003). This student-centered approach aligns with the high mean response of 3.68, suggesting teachers consistently prioritize meeting individual needs (Byrne, 2010; Hair et al., 2010). Similarly, Participant 2 focuses on teaching at the appropriate level, assessing prior knowledge, and utilizing differentiated instruction, principles central to catering to diverse learning needs (Tomlinson, 2001).

Fostering engagement is another key theme. Participant 1 advocates for making topics relevant, using hands-on activities, encouraging inquiry-based learning, incorporating multimedia, and collaborating with other teachers. These widely recognized strategies aim to increase student interest and motivation through relevance and interactive activities, enhance understanding and retention through active engagement and exploration, and cater to diverse learning styles through varied resources and collaboration (Astin, 1993; Bonwell & Eison, 1991). Similarly, Participant 2 recommends simple experiments, encouraging participation in science activities, and fostering the acquisition of scientific knowledge and skills. This aligns with experiential learning theory, highlighting the importance of direct engagement for effective learning (Kolb, 1984).

This study sheds light on science teachers' perceived practices in terms of pedagogical strategies. It reveals a focus on understanding students and fostering engagement, aligning with established educational principles and potentially contributing to effective science education and enhanced learning (National Research Council, 2012).One strength identified is teachers' emphasis on integrating new information with existing knowledge, evident in the highest mean score (3.89) and aligning with Participant 2's focus on understanding students' prior knowledge (Nicol et al., 2022). This practice, grounded in the constructivist approach, ensures new information builds upon existing knowledge, facilitating deeper understanding and learning (Piaget, 1973; Brooks & Brooks, 1999). However, an area for improvement emerged regarding organizing and integrating information during lessons. The lowest mean score (3.40) suggests potential room for development, aligning with research highlighting the importance of effective information organization and integration for student learning (Byrne, 2010; Hair et al., 2010). By effectively organizing and integrating information, teachers can enhance clarity, foster connections between concepts, and ultimately improve student comprehension.

Overall, this study suggests that while science teachers prioritize understanding students and integrating new information, there's room for improvement in organizing and integrating information during lessons. This finding emphasizes the importance of fostering a deeper understanding of these practices and their impact on student learning to ultimately improve science education and enhance science literacy (Hipkins et al., 2002). It's important

to remember that these findings are based on perceptions, not necessarily on teachers' actual practices in the classroom.

Actual literacy

The overall response for Actual literacy was 3.60 (SD = 0.355), indicating that this practice is highly practiced by the majority of teachers. The data distribution was normal with a skewness of -0.5615 and a kurtosis of -1.313, suggesting a slight negative skew and a platykurtic distribution, which means the distribution has lighter tails and fewer outliers (George and Mallery 2010).

On the other hand, the statement "Constructing unusual relationships to supply authentic solutions" received the lowest mean score of 3.40 (SD = 0.457), yet it still falls within the range of highly practiced. This suggests that while this teaching practice is recognized and implemented, there may be room for further emphasis or improvement in this area. This suggests that while this teaching practice is recognized and implemented, there may be room for further emphasis or improvement. This aligns with the notion of fostering creativity and critical thinking skills in problem-based learning environments (Hmelo-Silver 2004). The idea of constructing unusual relationships to supply authentic solutions is part of the creative thinking process, which is crucial in problem-solving (Paul and Elder 2006).

The participants have expressed that they have tried experimenting and taking risks in their teaching practices, even if there is a high chance of failure. Participant 1, for instance, has tried new approaches and gone above and beyond the comfort zone of what they normally do inside the classroom during the actual teaching. They acknowledge that it could be very risky, but they believe that this approach allows learning in a different way.Participant 2 has taken the risk of bringing students into science competitions like quiz bowls and science investigation projects (SIP). They believe that these experiences can help develop students' skills and let them experience how to do certain tasks.Participant 1 has experienced challenges for marginalized learners. This could imply that they have encountered difficulties in ensuring that all students, including those from marginalized groups, are able to effectively learn and develop science literacy. Participant 2, on the other hand, has expressed a sense of fulfillment in teaching. This suggests that they find joy and satisfaction in their role as a science teacher, particularly in relation to teaching and developing Science literacy among students.Participant 1's emphasis on understanding the learners and planning an approach that fits the learners' needs is reflected in the high mean response of 3.60, indicating that teachers consistently apply these pedagogical strategies in their teaching (George & Mallery, 2010).

The highest mean score of 4.00 for the statement "Students and Teachers are both Learners" aligns with Participant 1's focus on the reciprocal learning relationship between students and teachers. This suggests that teachers recognize and value this aspect of teaching practice (Palincsar& Brown, 1984; Vygotsky, 1978). Strengths lie in teachers' focus on understanding learners and acknowledging the reciprocal learning relationship. This aligns with student-centered approaches and promotes a collaborative learning environment where both students and teachers contribute to knowledge construction (Brooks & Brooks, 1999).

However, an area for improvement emerged regarding the development of creativity and critical thinking skills within problem-based learning environments. The lowest mean score (3.40) suggests potential room for growth in this area, which aligns with Participant 2's emphasis on problem-based learning but highlights the need to further equip students with the necessary skills to solve real-world scientific problems (Hmelo-Silver, 2004; Paul & Elder, 2006).

Overall, while science teachers prioritize understanding students and utilizing problem-based learning, developing creativity and critical thinking skills within these environments

requires further attention to fully equip students with the skills necessary for effective science literacy. By addressing this area, science education can better prepare students to think critically, solve problems creatively, and apply scientific knowledge in authentic contexts, ultimately enhancing their overall science literacy. Future research could explore specific strategies and techniques teachers can utilize to effectively foster these crucial skills within problem-based learning environments.

Post-literacy

The overall response of the Science teachers in the Post-literacy training was 3.58 with a standard deviation of 0.385. The qualitative response was Always Observed. The distribution of data was normally distributed with skewness and kurtosis of -0.562 and -1.031 (George and Mallery, 2010). When using the mean rating of 3.58 and a standard deviation of 0.385 (range 3.195 to 3.97), it could be meant that the greater majority of the teachers rated with highly practiced.

The highest rating was "Able to think the right way to learn in Science" (Mean=3.80, Sd=0.406) with a qualitative response of highly practiced. The lowest ratings were "Able to determine the cause and effect, analyze and draw conclusions" (Mean=3.40 and Sd=0.651) and "Clever in managing time to learn independently" (Mean=3.40 and Sd=0.553) with a qualitative response of highly practiced.The statement "Able to think the right way to learn in Science" received the highest mean score of 3.80, indicating unanimous agreement among the teachers on this aspect of teaching practice. This finding is consistent with the concept of scientific thinking, which involves questioning, investigating, and reasoning, and is considered a crucial part of science education (Verywell Mind 2023).

This underscores the importance of fostering scientific thinking in the classroom, as supported by existing literature. On the other hand, the statements "Able to determine the cause and effect, analyze and draw conclusions" and "Clever in managing time to learn independently" received the lowest mean scores of 3.40. These aspects of teaching practice are also recognized and implemented, but there may be room for further emphasis or improvement. The ability to determine cause and effect, analyze, and draw conclusions is a fundamental part of scientific inquiry and is crucial for developing students' critical thinking skills (Statistics Solutions 2023). This suggests that while these skills are being taught, there could be more focus on them to ensure students fully grasp these important aspects of scientific inquiry.

Similarly, the ability to manage time to learn independently is a key aspect of fostering independent learning, which is increasingly recognized as an important skill for students in the rapidly evolving global knowledge economy (Edutopia 2018). While this practice is being implemented, the data suggests that there could be more emphasis on teaching students how to effectively manage their time for independent learning.

When the participants sentiments on what they perceived their practices in developing Science literacy among students in terms of post-literace, Participant 1 has experienced challenges with students who have poor comprehension, are non-readers, or are non-participative. Despite these challenges, they identified key elements that contributed to their teaching experiences, including differentiated instruction, literacy interventions, cultivating a love for reading, and parent involvement. These elements highlight the importance of tailored teaching strategies, literacy support, fostering an interest in reading, and parental engagement in students' learning.

Participant 2's experiences, meanwhile, revolve around the process of data collection and analysis, output presentation, and writing and communicating results. They believe that key elements such as observation skills, data collection and analysis, and writing and

communication skills contribute to successful teaching and the development of science literacy among students.

When it comes to teaching and developing science literacy skills outside the school, Participant 1 suggests combining science-specific language with basic literacy skills and teaching students applications that are relevant to their daily lives. This approach emphasizes the integration of science and literacy skills and the importance of real-world relevance in teaching science. Participant 2 believes that being knowledgeable in science content is crucial. They suggest that students should discuss how they could apply learned science content into their everyday life. They also emphasize that teachers should motivate the students in learning. This approach underscores the importance of content knowledge, application of science in everyday life, and student motivation in teaching science.

Participant 1's emphasis on understanding the learners and planning an approach that fits the learners' needs is reflected in the high mean response of 3.58, indicating that teachers consistently apply these pedagogical strategies in their teaching (George and Mallery 2010).Strengths lie in teachers' focus on understanding learners, acknowledging the reciprocal learning relationship, and embracing risks to try new approaches. This aligns with student-centered learning and promotes a collaborative learning environment where both teachers and students contribute to knowledge construction (Palincsar and Brown 1984; Vygotsky 1978). Additionally, the emphasis on fostering creativity and critical thinking, particularly in problem-based learning environments, resonates with established principles in science education (National Research Council 2012).

However, the results also highlight areas for improvement. While teachers acknowledge the importance of problem-solving skills, the lowest mean scores suggest potential room for growth in areas like determining cause-and-effect, analyzing information, and drawing conclusions (Bybee 1997). Additionally, the data suggests a lesser emphasis on promoting student independence in terms of time management and independent learning (Saavedra and Halpern 2004).

Overall, the results imply a positive direction in teachers prioritizing learner-centered environments, creativity, and critical thinking. However, focusing on developing students' specific problem-solving skills and fostering their independence as learners could further enhance the efficacy of these practices in promoting science literacy. It is important to acknowledge that this analysis is based on a limited scope and further research with a broader sample could provide deeper understanding.

Experiences of teachers in teaching and developing Science literacy among students

The overall response of the experiences of science teachers in Teaching Science Literacy among students was 3.33 with a standard deviation of 0.516. The qualitative response was frequently encouraged. The distribution of data was normally distributed with skewness and kurtosis of -0.140 and -1.161 (George and Mallery 2010). When using the mean rating of 3.33 and a standard deviation of 0.516 (range 2.814 to 3.846), it could be meant that the greater majority of the teachers rated with highly experienced but some with a rating of experienced. This finding aligns with existing educational research emphasizing the importance of fostering science literacy for student success.

The practice of presenting a summary of recently learned content received the highest rating (Mean=3.60), underscoring the value of summarization in reinforcing learning and ensuring retention. This practice is consistent with the 5E instructional model, which highlights the importance of students integrating new science ideas with their prior experiences.

Conversely, the practice of discussing the subject matter in a fast-paced manner received the lowest rating (Mean=2.91), suggesting that teachers consistently avoid rushing through subject matter. This approach is beneficial as pacing significantly impacts comprehension. Slower, more deliberate discussions facilitate effective information absorption. However, it's important to note that the effectiveness of teaching strategies can vary based on factors such as the specific context, student population, and subject matter. Therefore, continuous professional development is crucial for teachers to adapt their strategies to their unique teaching contexts.

In conclusion, these findings underscore the importance of summarization and appropriate pacing in teaching science literacy. It also highlights the need for ongoing professional development to ensure the effective implementation of these practices in the classroom.

The overall response of the experiences of Science Teachers in Developing Science Literacy among students was 3.66 with a standard deviation of 0.407. The qualitative response was highly experienced. The distribution of data was normally distributed with skewness and kurtosis of -1.076 and -0.205 (George and Mallery 2010). When using the mean rating of 3.66 and a standard deviation of 0.407 (range 3.253 to 4.000), it could be meant that the greater majority of the teachers rated with highly experienced but some rated experienced.

The teaching strategy with the highest mean score is "grouping students into small groups for activities," with a mean of 3.83. This suggests that teachers frequently employ this strategy in their classrooms. The effectiveness of group work is well-documented in literature. For instance, Smith et al. (2011) found that group work improves academic achievement, enhances relationships with classmates and faculty, and promotes psychological well-being. Moreover, Johnson and Johnson (2009) noted that group work provides a peer instruction opportunity, allows students to view problems from multiple perspectives, and fosters creativity.

Conversely, the strategy with the lowest mean score is "giving students long-term projects or performance tasks," with a mean of 3.46. While this strategy is still frequently used, it is less common compared to other strategies. The importance of long-term projects is highlighted in the literature. Helm and Katz (2011) argued that long-term projects provide children with the opportunity to revisit their ideas and return to an existing project, leading to meaningful learning and development. Additionally, Bell (2010) emphasized that long-term projects demonstrate a child's ability to apply desired skills such as conducting research.

In terms of qualitative response, Participant 1 has experienced challenges with students who have poor comprehension, are non-readers, or are non-participative. Despite these challenges, they identified key elements that contributed to their teaching experiences, including differentiated instruction, literacy interventions, cultivating a love for reading, and parent involvement. These elements highlight the importance of tailored teaching strategies, literacy support, fostering an interest in reading, and parental engagement in students' learning.

Participant 2's experiences revolve around the process of data collection and analysis, output presentation, and writing and communicating results. They believe that key elements such as observation skills, data collection and analysis, and writing and communication skills contribute to successful teaching and the development of science literacy among students.

When it comes to teaching and developing science literacy skills outside the school, Participant 1 suggests combining science-specific language with basic literacy skills and teaching students applications that are relevant to their daily lives. This approach emphasizes the integration of science and literacy skills and the importance of real-world relevance in teaching science. Participant 2 believes that being knowledgeable in science content is crucial.

They suggest that students should discuss how they could apply learned science content into their everyday life. They also emphasize that teachers should motivate the students in learning. This approach underscores the importance of content knowledge, application of science in everyday life, and student motivation in teaching science.

The analysis delves into the experiences of science teachers in fostering science literacy among students, drawing on both qualitative responses and quantitative data.Participant experiences highlight diverse challenges and effective practices. Participant 1 grappled with students experiencing difficulties in comprehension, reading, or participation (Bybee 1997). However, they identified successful strategies like differentiated instruction, literacy interventions, fostering a love for reading, and parental engagement (National Research Council 2012). In contrast, Participant 2 focused on the importance of data collection and analysis, output presentation, and writing and communication skills for both teachers and students (Bybee 1997).

Both participants stressed the importance of teaching science literacy beyond the classroom. Participant 1 advocated for integrating science-specific language with basic literacy skills and providing students with real-world applications of scientific concepts (National Research Council 2012). Similarly, Participant 2 emphasized the need for content knowledge, applying science in daily life, and motivating students (Bybee, 1997).

Quantitative data revealed valuable insights into teachers' preferred instructional strategies. Presenting summaries of learned content received the highest mean score, reflecting the value of reinforcing learning through this technique (National Research Council 2012).

Conversely, fast-paced discussions received the lowest score, suggesting teachers prioritize slower, more deliberate instruction for better comprehension (National Research Council 2012). The most frequent strategy was grouping students for activities, aligning with research on the benefits of group work for learning and social development (Smith et al. 2011; Johnson and Johnson 2009). While long-term projects received the lowest mean score, they remain a valuable tool for deep learning and skill development (Helm and Katz 2011; Bell 2010).

The experiences of science teachers in fostering science literacy reveal both promising aspects and areas for growth. On the positive side, teachers prioritize understanding students and fostering engagement, aligning with established educational principles and creating a positive learning environment. Additionally, they recognize the reciprocal learning relationship between themselves and their students, promoting collaboration and knowledge construction. Furthermore, they value student-centered approaches like group work, which aligns with research on its benefits for both learning and social development. They also acknowledge the importance of fostering skills beyond comprehension in students, encompassing critical thinking, problem-solving, applying knowledge, and effective communication.

However, room for improvement exists in several areas. Teachers identified a need to better organize and integrate information during lessons, highlighting the need for further research on the link between perceived and actual classroom practices. Additionally, they acknowledged the need to further develop students' creativity and critical thinking skills within problem-based learning environments, as these skills are crucial for effective science literacy. Finally, there's potential room for improvement in developing specific problem-solving skills and fostering student independence, including aspects like time management and independent learning.

While science teachers demonstrate a strong commitment to fostering science literacy, the findings highlight areas for improvement, particularly in information organization, specific skill development, and fostering student independence. Addressing these areas, along

with further research exploring the link between perceptions and practices, can significantly enhance science education and ultimately improve science literacy. It's important to remember that these findings are based on teachers' perceptions and may not necessarily reflect their actual classroom practices.

In conclusion, Science teachers perceive a variety of instructional strategies as valuable in teaching developing science literacy, emphasizing student-centered approaches, real-world applications, and fostering a love for science beyond the classroom. They acknowledge the benefits of strategies like presenting summaries of learned content and grouping students for activities, while also recognizing the importance of slower, more deliberate instruction for better comprehension. However, they also identify a need to improve in areas like organizing and integrating information during lessons.

Challenges encountered by teachers in developing Science teaching and developing literacy among students

The overall mean response of the Science teachers in the challenges encountered in Teaching Science Literacy among students was 3.53 with a standard deviation of 0.468. The qualitative description was not challenged. The distribution was symmetrical with skewness and kurtosis of -0.793 and -0.5636 (George and Mallery 2010). When using the mean rating of 3.53 and a standard deviation of 0.468 (range 3.062 to 3.998), it could be deduced that the greater majority of the teachers rated with not challenged but some with a rating of less challenged. Most Science teachers reported not challenged in teaching science literacy, but there is some variation. Addressing less challenged ensures effective instruction and student engagement.
The highest rating was “I prepare pictures, models and other visual aids when discussing the topic” (Mean=3.66 and Sd=0.639) with a qualitative response of not challenged. This suggests that teachers frequently employ visual aids in their classrooms, which aligns with existing literature indicating that visual aids can significantly enhance the learning process by making abstract concepts more concrete and understandable (Smith et al. 2012).

On the other hand, the strategy with the lowest mean score is “I let my students write the topic on their notebook before I discuss the concept,” with a mean of 3.37 with a qualitative response of not challenged. While this strategy is still frequently used, it is less common compared to other strategies. This could be due to various factors such as time constraints or the perceived effectiveness of this strategy. However, note-taking is a crucial skill that helps students process and retain information better (Johnson and Johnson 2009).

The overall mean response of the Science teachers in the challenges encountered in Developing Science Literacy among students was 3.06 with a standard deviation of 0.597. The qualitative description was less challenged. The distribution was symmetrical with skewness and kurtosis of -0.737 and 0.0481 (George and Mallery 2010). When using the mean rating of 3.06 and a standard deviation of 0.597 (range 2.463 to 3.657), it could be deduced that the greater majority of the teachers rated with less challenged but some with a rating of not challenged and challenged. The qualitative description being “less challenged” implies that most teachers reported encountering challenges periodically. Existing literature supports these findings. For instance, Pan (2017) found that elementary school teachers often experience challenges in science teaching due to factors such as teacher education, and time and resources. This could explain why the majority of teachers in your study reported occasionally facing challenges, as these factors can vary and present periodic challenges.

The strategy with the highest mean score, “I guide my students to evaluate data and analyze it,” is supported by research indicating that data evaluation and analysis are crucial skills in science education. For instance, a study by the National Research Council (2006) emphasized that guiding students in data evaluation and analysis is a key component of

effective science instruction.On the other hand, the strategy with the lowest mean score, "I let my students read the procedures of an activity WITHOUT explaining the steps," aligns with research suggesting that students may struggle with understanding procedures on their own. A study by Zuhrieh Shana and Enas S. Abulibdeh (2020) found that practical work, including reading and understanding procedures independently, can promote independence and problem-solving skills but also presents challenges that may require additional guidance or explanation.

Student-related challenges are prominent, with both participants highlighting difficulties like poor comprehension, lack of prior knowledge, and limited subject matter knowledge. These findings echo the importance of strong literacy skills for learning science (Moeller 2006) and the need to build on existing knowledge while improving reading comprehension (National Research Council 2012). Beyond student characteristics, resource and curriculum limitations emerge as additional challenges. Participant 2 emphasizes the need for adequate materials, engaging activities, and a curriculum specifically designed to foster science literacy. This aligns with research highlighting the importance of such resources and curricula (Bybee 2013).

The data also sheds light on potential solutions. Participant 1's experiences suggest the value of differentiated instruction, literacy interventions, fostering a love for reading, and parental involvement, all reflecting a student-centered approach that prioritizes individual needs and abilities (National Research Council 2000).While commonalities exist in addressing student needs and fostering love for learning, specific challenges and potential solutions diverge. These findings showcase the complexity of developing science literacy and emphasize the need for a nuanced understanding of teachers' beliefs, practices, and the interplay with diverse challenges they encounter in nurturing this crucial skill in their students.

In conclusion, Science teachers encounter various challenges in developing science literacy, including addressing diverse student needs, developing specific skills, fostering creativity and critical thinking, and potentially facing additional, unreported challenges. Addressing these challenges through targeted strategies, professional development opportunities, and further research can significantly improve science teaching practices and ultimately enhance student science literacy.

Opportunities for teachers in developing Science teaching and developing literacy among students

The overall mean response of the Science teachers in the opportunities encountered in Teaching Science Literacy among students was 3.17 with a standard deviation of 0.393. The qualitative description was consistently having access to educational resources and materials. The distribution was symmetrical with skewness and kurtosis of 0.378 and -0.466 (George and Mallery 2010). When using the mean rating of 3.17 and a standard deviation of 0.393 (range 2.777 to 3.563), it could be deduced that the greater majority of the teachers rated with consistently having access to educational resources and materials but some with a rating of frequently having access to educational resources and materials. The result indicates that while the majority of teachers consistently have access to resources, some rated their access as frequent. This could imply that while resources are generally available, the frequency or consistency of access may vary among teachers.

The highest rating was "I emphasize that multiple data and the source of data must evaluate well before drawing any conclusion" (Mean=3.71 and Sd=0.458) with a qualitative response of frequently having access to educational resources and materials. The lowest rating was "I DO NOT allow students to manipulate or use science apparatus" (Mean=2.14

and Sd=1.033) with a qualitative response of Occasionally having access to educational resources and materials. Research by Samuelsen, Chen, and Wasson (2019) supports the importance of using multiple data sources for comprehensive understanding in education. This aligns with the high rating for the statement about evaluating multiple data sources before drawing conclusions.

On the other hand, Fadzil and Saat (2017) found that hands-on experience in science education is crucial. However, if students merely follow the lab manual without making real-life connections, the methods lose their value. This could explain the lower rating for the statement about not allowing students to manipulate scientific apparatus.

Furthermore, the overall mean response of the Science teachers in the opportunities encountered in Developing Science Literacy among students was 3.38 with a standard deviation of 0.471. The qualitative description was frequently having access to educational resources and materials. The distribution was symmetrical with skewness and kurtosis of -0.278 and -1.224 (George and Mallery 2010). When using the mean rating of 3.38 and a standard deviation of 0.471 (range 2.909 to 3.851), it could be deduced that the greater majority of the teachers rated with frequently having access to educational resources and materials but some with a rating of consistently having access to educational resources and materials. This indicates that while the majority of teachers frequently have access to resources, some rated their access as consistent. This could imply that while resources are generally available, the frequency or consistency of access may vary among teachers.

Highly rated strategies that involve creating connections between topics and integrating games into learning indicate that students react positively to engaging and interactive teaching methods. This is corroborated by research that suggests literacy strategies enable students to enhance their understanding of science and to perform and communicate scientific concepts. The ability to read and write scientific texts and diagrams, for instance, aids students in comprehending complex scientific knowledge and processes.

The strategy of providing topics for students to debate received a lower rating, which could be attributed to several factors. While debates can cultivate skills such as abstract thinking, citizenship and etiquette, clarity, organization, persuasion, public speaking, research, and teamwork and cooperation, they might not be as well-received if not executed effectively. For example, students might find it difficult to participate in debates if they are not given adequate resources or guidance. This is reflected in research that implies the effectiveness of debates as a teaching strategy hinges on the level of responsibility for learning and active participation demanded from all student debaters.

The researcher further delved into the opportunities for science teachers to enhance their practice, drawing insights from key informant interviews with two participants. Both participants highlight professional development through higher studies and seminars as valuable for acquiring advanced knowledge, skills, and exposure to new teaching strategies and technologies, echoing the importance of continuous learning for educators (Desimone 2009).

Additionally, staying updated with scientific advancements and being innovative in teaching approaches are seen as crucial by Participant 1. This aligns with research advocating for incorporating new content and engaging methodologies (National Research Council 2012). Furthermore, Participant 2 emphasizes the use of higher-order thinking skills like analysis and evaluation in teaching, which aligns with research on fostering deeper understanding and application of science concepts (National Research Council 2012). Both participants identify opportunities related to student engagement. Participant 1 sees innovation in teaching methods, potentially through project-based or inquiry-based learning or using digital technologies, as key. Participant 2 emphasizes the use of information and communication technology (ICT), which can provide diverse learning resources like simulations (Moeller

2008). These approaches resonate with research advocating for engaging and technology-integrated learning environments. However, it is important to acknowledge limitations. The high score for "experimenting" may not translate to consistent access to resources, and the focus on specific practices like data analysis doesn't fully encompass broader opportunities within science education. Additionally, the limited sample size restricts generalizability.

In conclusion, the research revealed promising avenues for improving science teachers' practice and fostering science literacy among students. These include continuous professional development through higher studies and seminars, allowing them to gain advanced knowledge, skills, and exposure to new teaching strategies and technologies. Staying current with advancements in science and science education ensures teachers can incorporate the latest content and pedagogical methods, keeping students engaged and learning the most relevant information.

Adopting innovative teaching approaches like project-based or inquiry-based learning, or utilizing digital technologies, can create engaging and effective learning experiences that cater to diverse learning styles. Promoting higher-order thinking skills in students, such as analysis and evaluation, fosters deeper understanding and application of science concepts, preparing them to think critically and solve problems effectively. Finally, utilizing engaging strategies like project-based learning, inquiry-based learning, and information and communication technology (ICT) can enhance student engagement and understanding, making science learning more interesting, relevant, and ultimately, more impactful. By exploring and implementing these opportunities, we can empower science teachers to create a learning environment that fosters a generation of scientifically literate individuals, equipped with the knowledge and skills to navigate an increasingly complex and science-driven world.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The study provides valuable insights into science teachers' perceptions of their practices in fostering science literacy among students. It reveals that teachers generally prioritize a comprehensive approach that includes content knowledge, pedagogical strategies, and actual and post-literacy skills.

Teachers recognize the importance of a strong foundation in scientific concepts and employ various strategies to engage students. However, the study identifies room for improvement in how information is organized and presented during lessons. This is crucial as effective organization and presentation of information can significantly enhance students' comprehension and learning experience.

While problem-solving is emphasized in teaching practices, there's potential to further develop students' critical thinking skills. This includes areas such as analyzing information, drawing conclusions, and identifying cause-and-effect relationships. These skills are fundamental to science literacy as they enable students to understand and interpret scientific information effectively.

The study also suggests a need for increased focus on teaching students time management and independent learning skills. These skills are essential for students to effectively manage their learning process and become self-directed learners. However, the study acknowledges the challenges in ensuring all students, including those from marginalized groups, can effectively develop science literacy. This highlights the need for differentiated instruction and inclusive teaching practices to cater to the diverse needs of students.

Overall, the study underscores the importance of continuous professional development for teachers. Staying updated on scientific advancements and integrating effective

pedagogical strategies are crucial for enhancing teaching practices. By addressing these areas for improvement and fostering a strong foundation in science content, teachers can empower students to develop critical thinking skills, solve problems effectively, and apply scientific knowledge in real-world contexts. This not only enhances science literacy but also prepares students to be successful in a science-driven world.

Science teachers reported positive experiences in fostering science literacy among students. They prioritize understanding students and fostering engagement through various strategies like summarizing learned content, grouping students for activities, and incorporating real-world applications. However, they also identified areas for improvement, such as information organization during lessons, developing creativity and critical thinking skills, and fostering student independence in areas like problem-solving and time management. Overall, the findings suggest that science teachers are committed to developing science literacy but could benefit from further support in specific areas.

Science teachers reported encountering challenges in developing science literacy, though to varying degrees. Most felt comfortable using visual aids and student note-taking, but some found aspects like independent student data analysis and letting students read activity procedures without explanation less straightforward.

While some teachers reported no challenges in teaching science literacy, the majority acknowledged occasional difficulties. Common challenges included student-related issues like poor comprehension and lack of prior knowledge, alongside limitations in resources and curriculum design.

The data suggests potential solutions lie in differentiated instruction, fostering a love for reading, and parental involvement, all focused on addressing individual student needs. Overall, the findings highlight the complexity of developing science literacy and the need for ongoing support for teachers in navigating this crucial aspect of science education.

The findings suggest that teachers have opportunities to improve their science teaching and develop students' science literacy. These opportunities include having consistent access to educational resources and materials, which allows them to implement effective strategies like allowing students to manipulate scientific apparatus and emphasizing the use of multiple data sources.

Encouragingly, teachers reported positive student reactions to engaging methods like creating connections between topics and integrating games into learning. However, some opportunities require careful implementation, such as providing topics for student debates. Here, ensuring students have adequate resources and guidance is crucial for success.

Overall, the study highlights the importance of professional development for teachers. This allows them to stay updated on scientific advancements and integrate new content and engaging methodologies into their teaching. Additionally, innovative approaches like project-based learning and the use of technology can create a more captivating learning environment for students. By exploring these opportunities, teachers can empower students to develop critical thinking skills and a deeper understanding of science concepts, preparing them to be successful in a world increasingly reliant on science.

Recommendations

These findings hold valuable implications for improving science education practices. By incorporating professional development programs that emphasize effective information organization, fostering critical thinking skills, and promoting student independence, teachers can be better equipped to cultivate a strong foundation in science literacy among students. However, the current study was limited by its focus on teacher perceptions. Future research employing larger and more diverse samples, alongside observations of classroom practices and student learning outcomes, could provide a more comprehensive picture. Additionally,

investigating the experiences of marginalized learners in greater depth could offer valuable insights into tailoring science instruction for inclusive and equitable science literacy development.

COMPLIANCE WITH ETHICAL STANDARDS

This study was conducted in strict adherence to ethical standards. Informed consent was obtained from all participants, who were assured of their right to withdraw from the study at any time without penalty. Anonymity of the respondents was maintained throughout the study, and all personal identifiers were removed to protect the respondents' confidentiality to the fullest extent permitted by law.

The well-being of the respondents was safeguarded at all times. Participation in the study was voluntary and non-coercive, and participants were given a token of appreciation for their time, information, and assistance in the study. The research posed no harm to the respondents.

The researcher declared no potential conflict of interest in conducting the study. The research had passed the ethical review and provided the ethical clearance from the Research Ethics Committee of Ateneo de Zamboanga University (ADZU), further affirming its adherence to ethical standards.

Plagiarism was strictly avoided, and there was no bias in the interpretation of the findings. The results were used purely for research purposes. Hard copies of the completed survey tool were stored with the utmost confidentiality for at least one year after the study's completion, after which they were shredded and disposed of, and all soft copies in the Google Drive were permanently deleted.

In conclusion, this study was conducted with a high level of integrity and respect for ethical standards, ensuring the protection of participants and the validity of the research findings. The study's design and implementation reflect a commitment to ethical research practices, including obtaining informed consent, maintaining respondent anonymity, safeguarding respondent well-being, avoiding conflicts of interest, and using the results purely for research.

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