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Research Article

The Quality of Science Education: Viewpoints of Secondary School Science Teachers

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Abstract
In today's world, the success of a society is increasingly tied to its ability to cultivate a scientifically literate population. Yet, many nations struggle to provide a solid foundation in science education, especially in under-privileged regions. Science education plays a crucial role in shaping the future of societies by fostering critical thinking, innovation, and scientific literacy among students (DepEd, 2020). This qualitative research study explores the perceptions of secondary school science teachers regarding the current state of science education in the Philippines, specifically focusing on the province of Bukidnon. The primary objectives of the study are to understand teachers' viewpoints on science education, identify significant barriers that hinder quality instruction, and propose actionable solutions to these challenges. The thematic analysis of the data reveals a notable increase in student interest and engagement, driven by factors such as rising enrollment in STEM programs and active participation in science fairs. Despite these positive trends, ongoing concerns about teacher quality, inadequate resources, and outdated curricula continue to impede effective science instruction in the classroom. Key barriers identified include insufficient teacher preparation, foundational gaps in student comprehension, and constraints on resources, such as limited access to laboratory activities and essential equipment. The findings emphasize the pressing need for program restructuring, the early introduction of science concepts, and the integration of prerequisite courses designed to enhance the overall effectiveness of science education programs. These recommendations aim to better equip future science educators and foster a more conducive learning environment. Ultimately, this research contributes valuable insights to ongoing efforts aimed at improving science education in the Philippines, underscoring the necessity of addressing systemic issues to promote a more effective, equitable, and enriching educational experience for all students.

Keywords: Current State, Key Barriers, Perceptions, Potential Solutions, Science Education

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1. INTRODUCTION

In today's world, the success of a society is increasingly tied to its ability to cultivate a scientifically literate population. Yet, many nations struggle to provide a solid foundation in science education, especially in under-resourced regions. According to the recent PISA results in 2022, only 23% of students in the Philippines attained Level 2 or higher in science (OECD average: 76%). At a minimum, these students can recognize the correct explanation for familiar scientific phenomena and can use such knowledge to identify, in simple cases, whether a conclusion is valid based on the data provided (OECD, 2023). This striking figure highlights a pressing issue: the struggle to achieve high-quality science education in the Philippines, especially in rural and marginalized areas. As the Philippine Department of Education (DepEd) endeavors to align the curriculum with modern standards, the gap between policy aspirations and classroom realities

remains a critical concern (DepEd, 2020). Addressing this gap is vital for fostering analytical thinking, creativity, and a genuine enthusiasm for scientific exploration among students.

Despite widespread recognition of the importance of science education in preparing students for the future, numerous barriers continue to hinder progress. For instance, Cruz and Abian (2019) identify inadequate infrastructure as a key challenge, with many schools, especially in rural areas, lacking the necessary facilities. Additionally, the shortage of laboratory spaces and outdated equipment further limits students' opportunities for hands-on learning, curbing their exposure to practical applications of scientific concepts (Pulhin & Castillo, 2018).

Furthermore, the lack of qualified science teachers exacerbates the situation (DepEd, 2020). This shortage leads to a decline in both the quality of instruction and the depth of students' understanding, making it difficult for learners to grasp complex scientific ideas and develop a genuine interest in the subject (Upadhyay, 2019). In addition to staffing challenges, the use of outdated curricula poses another significant issue. Many educational frameworks are slow to integrate recent scientific developments and fail to address evolving societal needs. Consequently, this disconnect creates a gap between the knowledge students acquire in the classroom and its practical application in daily life (Santos, 2020), ultimately stunting the development of critical thinking and openness to new scientific ideas.

Moreover, socioeconomic disparities add another layer of complexity to these challenges. Access to effective science education is often determined by a student's location, financial resources, and social status (Smith, 2020). As a result, this inequity not only perpetuates existing societal divides but also limits the country's ability to fully tap into the talent and potential of its young people.

Nevertheless, within these challenges lie opportunities for significant improvement. Addressing these obstacles is more than an academic exercise—it is a necessity that can drive targeted interventions, fostering a transformative science education experience in the Philippines. Through gathering insights from secondary science teachers about the current state of science education and recognizing the specific barriers they face, stakeholders—policymakers, educators, and parents—can work together to create an environment that nurtures curiosity, critical thinking, and hands-on learning among students.

Thus, this research focuses on exploring the state of science education in the region through the perspectives of science educators, as well as identifying the challenges that hinder the delivery of quality education. It aims to highlight areas for improvement, contributing to ongoing efforts to enhance the educational experience for secondary students across the country.

2. METHODS

2.1. Research Design

This study employed a qualitative phenomenological research approach to explore the lived experiences and perceptions surrounding secondary science education in the Philippines. Phenomenology enables a thorough exploration of teachers to understand their educational experiences in the field of science education. Focusing on the real-life experiences of teachers provides significant perspectives on the difficulties and possible ways to improve the quality and significance of science education in the country.

2.2. Participants

The primary respondents of the study are secondary school science teachers currently teaching in public and private schools within the province of Bukidnon. The selection criteria consist of teachers who have a minimum of five years or more teaching experience in science subjects at the secondary level, educators engaged in teaching science-related topics like Biology, Chemistry, Physics, and General Science at Junior and Senior High School, and teachers willing to voluntarily contribute honest and insightful feedback on the quality of science education in the Philippines.

2.3. Research Instruments

The primary data collection instrument for this study was a standardized semi-structured interview guide. The interview guide consisted of open-ended questions designed to elicit detailed responses from participants regarding their perceptions on the current state of science education in the country, experiences, and challenges related to science education in the Philippines. The interview guide was developed anchored on the research objectives and has undergone pilot testing to ensure clarity and relevance.

2.4. Procedures

Data collection was conducted through face-to-face or virtual semi-structured interviews with the selected participants. Interviews were audio-recorded with participants' consent and transcribed verbatim for further analysis. The interviews were conducted in a comfortable and confidential setting to encourage open and honest communication with the secondary school teachers.

2.5. Data Analysis

Thematic analysis was employed to analyze the interview data and identify patterns, themes, and categories relevant to the research objectives. The process involved coding the transcripts, organizing codes into themes, and interpreting the underlying meanings and relationships. Data analysis was conducted manually, ensuring rigor and consistency in the interpretation of findings.

3. RESULTS

This study investigated the perceptions of secondary school science teachers in Bukidnon, Philippines, regarding the quality of science education, the barriers that hinder quality instruction, and the presentation of actionable solutions to the perceived challenges in science education. The following are the key findings organized accordingly:

3.1. On the Perception of Secondary Science Teachers on the Current State of Science Education

Table 1. Thematic Matrix of Science Teachers' Perception on the Current State of Science Education

Subthemes	Emergent Themes
Growing STEM enrollment reflects increasing student interest	Student Interest and Engagement
Rising popularity of science fairs enhances engagement	
Increased community understanding of science research importance promotes literacy	
Growing school engagement in research fosters scientific exploration	
Increased emphasis on STEM education fosters critical thinking skills	
Increased research exposure enhances scientific abilities	
Insufficient teacher quality hampers effective education	Teacher Quality and Training
Inadequately trained teachers impede quality education	
Teacher qualifications and shortage hinder effective education	
Limited availability of equipment impedes hands-on learning	Resources and Equipment
Limited access to laboratory equipment hinders practical learning experiences	
Inadequate resources	
Outdated science programs and need urgent reform	Curriculum and Instruction
Outdated curriculum restricts students' readiness to modern demands	
Delayed science concept introduction affects foundational knowledge	

Based on Table 1, teacher quality and training and curriculum and instruction are the key emergent themes that must be addressed. The findings indicate significant concerns regarding the quality and training of secondary science teachers. These findings emphasized the necessity of improving teacher training

programs, equipping educators with the essential skills to address language barriers and enhance instructional delivery. Further, this suggests that an investment in comprehensive professional development and ongoing training could lead to more effective teaching practices and help improve student outcomes.

Also, the analysis revealed that the curriculum and instruction in the current science curriculum are perceived as outdated and misaligned with modern educational demands. This implies an urgent need for curriculum reforms that incorporate current scientific knowledge and pedagogical practices to foster student engagement and understanding.

3.2. On the Key Issues and Barriers Hindering the Achievement of Quality Science Education

Table 2. Thematic Matrix of the Key Issues and Barriers that Hinders Quality Science Education

Subthemes	Emerging Themes
Content mastery poses a significant challenge among science teachers Inadequate preparation during college affects teaching proficiency	Teacher Preparation and Proficiency
Weaknesses in foundational subjects like English and mathematics hinder student comprehension and engagement Students struggle with foundational concepts, impacting their ability to grasp higher-level science topics Limited use of mother tongue in instruction creates gaps in understanding	Student Foundation and Comprehension
Students' conceptual understanding in science is lacking	Student Conceptual Understanding
Teachers' presentation and engagement levels influence student perceptions and learning outcomes	Teacher Presentation and Engagement
Limited exposure to laboratory activities hampers student engagement and empowerment in learning science Inadequate laboratory equipment and manuals hinder hands-on experiments and engagement	Resource Constraints
Managing large classes limits individualized attention and addressing diverse learning needs Time constraints lead to prioritization of topics, potentially overlooking important concepts	Classroom Dynamics and Time Constraints
Insufficient professional development opportunities leave teachers ill-equipped to adopt new teaching methods and technologies Limited support and training in science education at regional and national levels	Professional Development and Support
Competing distractions from technology and other subjects reduce student engagement in science lessons	Student Distractions

Based on Table 2, the two major key findings are the student foundation and comprehension and resource constraints. Findings in student foundation and comprehension indicate that weaknesses in foundational subjects, particularly English and mathematics, significantly impact students' comprehension of science concepts. This highlights the critical role of foundational literacy and numeracy skills in enabling students to grasp complex scientific principles. This implies that targeted interventions in foundational education could enhance overall science education outcomes, thereby improving students' ability to engage with and understand scientific content. Also, the resource constraints as a major barrier to effective science education emphasize the need for increased investment in educational resources, which could lead to a more interactive and engaging science learning environment, ultimately fostering a deeper understanding of scientific principles among students.

3.3. On the Potential Solutions to Address the Identified Issues and Barriers in Science Education

Based on Table 3, the results indicate a positive trend towards program restructuring and curriculum innovations that relate science instruction to real-world situations. This suggests that aligning science education with societal challenges can enhance student motivation and participation. The consequentially

implies the importance of promoting STEM initiatives and integrating real-world applications into the curriculum, which could further stimulate student interest and engagement in science.

Table 3. Thematic Matrix of the Key Issues and Barriers that Hinders Quality Science Education

Subthemes	Emerging Themes
Provide workshops, trainings, conferences, and seminars for teachers to enhance their knowledge and teaching skills	Teacher Training and Development
Offer refresher courses on prerequisite subjects like pre-calculus and basic calculus	
Offer hands-on training for teachers on laboratory equipment usage and research skills	
Provide comprehensive training sessions, workshops, and mentorship programs for teachers to improve teaching methods and stay updated on scientific advancements	
Offer ongoing mentorship programs and access to resources for continuous professional development.	
Include teachers in curriculum development	Curriculum Enhancement
Revise the curriculum to incorporate inquiry-based learning approaches and ensure alignment with global standards	
Restructure senior high school programs to streamline subjects and prioritize STEM-related courses	Program Restructuring
Implement early introduction of science concepts in foundational education stages to strengthen conceptual understanding	
Address resource shortages in schools, especially in rural areas, by providing adequate laboratories and textbooks	Resource Provision
Promote STEM education, community engagement, and implementation of evaluation mechanisms to enhance overall science education quality	Promotion of STEM Education

4. DISCUSSION

4.1. On the Perception of Secondary Science Teachers on the Current State of Science Education

Theme 1: Student Interest and Engagement

The perception of secondary science teachers on the current state of science education in the Philippines reveals a growing emphasis on student interest and engagement. Stemming from a rise in STEM enrollment and the increasing popularity of science fairs, educators acknowledge the pivotal role of engaging activities in fostering student curiosity and involvement in science-related disciplines. Furthermore, the community's growing understanding of the importance of science research literacy and the active participation of schools in scientific exploration signal a positive trend towards nurturing students' interest and engagement in science education.

This theme is supported by the following responses from the key informants:

> *"I think the growing number of students enrolling in STEM education in a senior high school program, that would mean that the students are becoming more interested in the science education." Key Informant 1*

> *"There has been a wide dissemination and understanding of the community, education community in general, and the importance of science research. A lot of schools are already engaging in science research and have explored a lot of areas in the country which actually could be used to further our economy, our knowledge in terms of science research in general." Key Informant 2*

> *"…students are increasingly exposed to and trained in conducting research, which helps improve their scientific skills and abilities." Key Informant 3*

These findings correlate to (Santos & Cruz, 2022), which emphasizes the involvement and interest of students in science education. The emergence of the STEM strand in secondary school increases the number of student enrollees, consequentially implying an increasing interest in science-related disciplines.

In addition, science fairs have gained popularity in the Philippines, which provides students with opportunities to explore scientific principles through hands-on projects and presentations.

Theme 2: Teacher Quality and Training

The theme highlights concerns regarding the quality and training of secondary science teachers in the Philippines. It reflects challenges related to insufficient teacher preparation during college, a shortage of qualified educators, and limited opportunities for professional development. These issues underscore the importance of enhancing teacher quality and providing adequate training to ensure effective science education delivery.

This theme is supported by the following responses from the key informants:

"…some teachers are not trained well enough to teach sciences. In fact, there are teachers that are not science teachers that are asked to teach science. So there is a problem in terms of the content and the skills that is required by the teacher." Key Informant 2

"…the qualities of science teacher… these are the same weaknesses even before." Key Informant 1

"One major issue is the lack of qualified teachers, which hinders effective teaching and learning." Key Informant 3

The findings could be attributed to Wei et al. (2009) wherein they found a positive association between student accomplishment and teacher quality, meaning that children taught by highly effective teachers often showed more significant levels of academic achievement. Additionally, research said that instructors with comprehensively trained instructors have higher gains in student success than teachers with less training. It emphasized attracting and keeping highly competent teachers to improve student learning.

Theme 3: Resources and Equipment

This theme addresses the challenges posed by inadequate resources and equipment in science education. It encompasses issues such as the limited availability and access to laboratory equipment, which hampers hands-on learning experiences. Insufficient resources further compound these challenges, emphasizing the need for comprehensive support to create optimal learning environments for students.

This theme is supported by the following responses from the key informants:

"…, the equipment in school, these are the same weaknesses even before." Key Informant 1

"Not all students have access to laboratory equipment, the same way that some teachers are also not trained in terms of using the laboratory equipment." Key Informant 2

"One major issue is the lack of adequate resources, including laboratories, equipment." Key Informant 3

The research of Johnson et al. (2020) further supports the results above. It revealed that access to various tools and resources improved science learning outcomes and student engagement. It emphasized the significance of practical experiences and experimental activities in well-equipped science laboratories.

Furthermore, Wong & Chiu (2018) added that students expressed higher levels of motivation and interest in science when provided with a wide range of resources and well-equipped laboratories. These resources included interactive simulations, multimedia materials, models, and scientific instruments that stimulated students' curiosity, facilitated active learning experiences, and fostered a sense of ownership and autonomy in their scientific inquiries.

Theme 4: Curriculum and Instruction

The theme focuses on concerns regarding outdated curriculum and instructional practices in science education. It highlights the need for urgent reforms in science programs and curriculum development to align with modern educational demands. Issues such as delays in introducing foundational science concepts and an overreliance on rote memorization hinder students' conceptual understanding and practical application of knowledge.

This theme is supported by the following verbatim responses from the key informant:

> *"I personally think that when it comes to curricula, there's already like constant changes when it comes to the curricula, but for me it's the implementation itself." Key Informant 1*

> *"…the science curriculum is outdated and fails to prepare students adequately for the demands of the modern world. This means that the topics and methods taught in science classes may not reflect the latest developments in scientific knowledge and technology. As a result, students may graduate without the necessary skills and knowledge to succeed in fields like STEM (Science, Technology, Engineering, and Mathematics) or to address contemporary global issues such as climate change or public health crises." Key Informant 3*

The curriculum and instructional practices fail to keep pace with societal changes, technological advancements, and evolving educational research, students may experience disengagement, decreased motivation, and reduced learning outcomes (Smith & Johnson, 2019). Outdated curricula may lack relevance to students' lives, address current societal issues, or neglect to integrate new knowledge and skills required in the modern world. The outmoded teaching strategies ineffectively engage students or ineffectively develop their capacity for critical thought and problem-solving. Hence, continuous curriculum updates help ensure a relevant, engaging, and practical education.

4.2. On the Key Issues and Barriers Hindering the Achievement of Quality Science Education

Theme 1: Teacher Preparation and Proficiency

The theme sheds light on the challenges faced by science teachers in terms of their readiness and competence in delivering effective education. It underscores the significance of adequate training and content mastery among educators, which are essential for imparting knowledge and fostering student learning. The subthemes generated from key informants' responses emphasize the persistent issue of content mastery among science teachers, indicating a need for improved training programs and support mechanisms during their college education.

The verbatim quotes provided underscore the critical role of teacher preparation in ensuring quality science education delivery and highlight the ongoing challenges faced by educators in mastering subject content:

> *"So there have been numerous factors that we can science education teachers but for me it's still the same content mastery. Still content mastery." Key Informant 1*

> *"…and not only when we're already teaching but if these contents were not presented very well by the teachers, while we are still preparing in college. That becomes problematic." Key Informant 1*

The results attributed to the study of Stronge et al. (2018) showed a considerable favorable impact on student learning outcomes for instructors with thorough preparation. This further clarified that developing pedagogical abilities, content knowledge, and classroom management techniques is the primary goal of successful teacher training programs.

Theme 2: Student Foundation and Comprehension

This theme delves into the foundational aspects of student learning in science education, particularly focusing on the challenges stemming from weaknesses in subjects like English and mathematics. It sheds light on how deficiencies in these foundational subjects hinder students' comprehension and engagement in science topics, ultimately impacting their ability to grasp higher-level scientific concepts.

This theme is supported by the following verbatim responses of the key informants:

> *"…students are weak when it comes to foundational subjects, and that's English and mathematics. For example, mathematics. How can they proceed in understanding, let's say for example, calculations in physics, in chemistry, if they're weak in these foundational concepts in math, like basic addition, subtraction, conversion?" Key Informant 1*

> *"Teachers cannot use mother tongue all the time because exams are presented in English language and that becomes problematic, that creates gap." Key Informant 2*

The result above correlates to a Snow et al. (1998) study that revealed that comprehension skills, like inferencing, summarizing, and prior knowledge, are crucial for understanding complex texts and acquiring new expertise across various subject areas. This result underscored that a solid foundation in literacy and strong comprehension skills are the building blocks for academic success, critical thinking, and continued learning throughout students' lives.

Early math skills predict later academic achievement, not only in math but also in other subjects (Ramani & Siegler, 2008). A solid math foundation could be possible for all students through understanding numbers and logical inference in solving practical problems. This is crucial for success in fields such as science, technology, engineering, economics, and finance.

Additionally, the students' academic and professional prospects are rooted in their strong reading and writing skills in English. Neuman & Dickinson (2011) highlighted the critical role of early literacy development in children's language acquisition, cognitive development, and academic achievement. Students' ability to understand complicated texts, evaluate arguments, and effectively express themselves in writing is a function of their reading comprehension proficiency. All these skills are vital for success across all subject areas and are essential for higher education and career advancement.

Theme 3: Student Conceptual Understanding

Addressing students' conceptual understanding in science, this theme highlights gaps in comprehension and conceptual mastery. The subthemes suggest that students' understanding of scientific concepts is lacking, potentially due to limitations in instructional methods or resources. This theme underscores the importance of fostering deeper conceptual understanding among students. This is supported by the following response:

> *"I have seen personally as a teacher and also from the experience of my fellow science teacher is the conceptual understanding of students in science. Also the level of engagement in science and the level of preparedness of teachers in terms of preparing students or preparing lessons and experiences for them to have a firm grasp of science concepts." Key Informant 2*

This theme highlights gaps in comprehension and conceptual mastery in science. The subthemes suggest that insufficient instructional methods or resources affect students' knowledge of scientific concepts. It underscores the importance of fostering deeper conceptual understanding among students. The response implies that addressing these challenges needs to improve teachers' preparedness and enhance students' engagement. Through providing meaningful learning experiences and fostering a supportive learning environment, educators can help students develop a deeper understanding of scientific principles.

These results anchor to Hestenses et al. (1995), which revealed that learners with a thorough conceptual grasp of physics' foundational ideas were better at solving problems and exercising critical thought. However, students with a superficial understanding of the subject frequently struggled to solve difficulties and turned to rote memorization.

In addition, Hestenes & Halloun (1995) and Bransford et al. (2000) emphasized that students with a solid conceptual foundation are better equipped to apply their knowledge to new situations, make connections across scientific disciplines, and engage in scientific reasoning and problem-solving. There is a correlation between student involvement, instructor readiness, and student comprehension.

Theme 4: Teacher Presentation and Engagement

This theme emphasizes the role of teachers' presentation styles and engagement levels in shaping student perceptions and learning outcomes. The subthemes suggest that effective science education delivery is closely tied to educators' ability to engage students and present the material in an accessible and engaging manner.

This is supported by an excerpt of the key informant's response:

> *"One of the things that I've seen as a main problem that I have seen personally as a teacher is the level of engagement in science and the level of preparedness of teachers in terms of preparing students or preparing lessons and experiences for them to have a firm grasp of science concepts." Key Informant 2*

These findings correlate to Fredricks et al. (2004), which revealed that instructors positively affect students' learning and performance through interactive exercises, multimedia materials, and visual aids in their presentations. It emphasized that effective teacher presentation and engagement strategies promote active student involvement.

Moreover, several studies demonstrated a favorable correlation between enhanced learning outcomes, conceptual comprehension, and long-term memory retention with high levels of involvement in science (Bransford et al., 2000; Fredricks et al., 2004). Active students' participation includes research scientific quests and practical experiments and poses critical questions. This active involvement fosters deeper comprehension, critical thinking, and a sense of ownership over their learning (Bybee, 2014; National Research Council, 2015).

Theme 5: Resource Constraints

Addressing limitations in resources and equipment, this theme highlights challenges such as limited exposure to laboratory activities and inadequate laboratory equipment. The subthemes that were generated indicate that these constraints hinder students' engagement and empowerment in learning science.

This theme is supported by some excerpts of the key informants' responses:

> *"One of the things that actually encourages students to learn science is that they feel they are empowered in terms of learning science. And that can only be done if they are exposed to laboratory activities and their teacher also is not that engaging in terms of presenting the lesson, then the problem is there. So there is less engagement and more or less students more or less have a negative perception of science subjects." Key Informant 2*

> *"…innadequate laboratory equipment and manuals, I find it challenging to conduct hands-on experiments and create engaging learning experiences for my students." Key Informant 3*

A research study conducted by Brown et al. (2017) demonstrated that a shortage of resources affected educational standards, such as inadequate funding, restricted technology access, and teaching materials scarcity. Insufficient resources impacted student motivation and engagement. Students also voiced discontent with their academic experiences due to their restricted access to modern textbooks, scientific tools, and other learning resources. It highlights that resource constraints can exacerbate educational disparities and impede students' academic progress.

Theme 6: Classroom Dynamics and Time Constraints

This theme reflects challenges such as managing large classes and time limitations in covering science topics. The subthemes generated suggest that these factors impact individualized attention and the prioritization of concepts in science education.

This is supported by the responses of the key informant:

> *"…managing large classes limits my ability to provide individualized attention and address their unique learning needs effectively." Key Informant 3*

> *"Time constraints force me to prioritize certain topics in the extensive science curriculum, sometimes overlooking important concepts" Key Informant 3*

The response underscores the detrimental effects of classroom dynamics and time constraints on science education. Managing large classes restricts individualized support, while time limitations force educators to prioritize topics, potentially sacrificing the thorough exploration of essential scientific concepts.

This result correlates to Weinstein et al. (2000) which showed that respectful interactions in the classroom created a favorable classroom dynamic that supported a supportive learning environment.

Further, limited time to cover the curriculum leads to fewer opportunities for meaningful participation and cooperation in class deliberation.

Theme 7: Professional Development and Support

Highlighting the importance of professional development and support for science educators, this theme addresses issues such as insufficient opportunities for training and support in adopting new teaching methods and technologies. The subthemes underscore the need for ongoing professional development to enhance teaching effectiveness and stay abreast of advancements in science education.

This is supported by the following excerpts:

> *"…the minimal professional development opportunities provided by the school leave me with insufficient training and support to stay updated on the latest teaching methods, technologies, and scientific developments." Key Informant 2*

> *"…limited support in terms of teacher training in Science at both regional and national levels." Key Informant 3*

The responses underscore the critical role of professional development and support in overcoming barriers to quality science education. According to Desimone (2009), relevant and job-embedded professional development opportunities positively influenced teachers' knowledge, skills, and instructional practices. Additionally, improved student learning outcomes and the implementation of research-based instructional practices were possible for teachers with access to peer collaboration and mentorship [26].

Furthermore, science instructors who participated in high-quality professional development reported feeling more confident in their teaching ability and showed a better usage of inquiry-based instructional techniques (Banilower et al., 2013).

Theme 8: Student Distractions

This theme discusses the impact of competing distractions, such as technology and other subjects, on student engagement in science lessons. The subthemes suggest that these distractions may reduce students' focus and interest in science education, emphasizing the importance of creating conducive learning environments that minimize distractions and promote student engagement.

This theme is supported by the following response:

> *"Competing distractions from technology and other subjects further hinder students' engagement in science lessons.." Key Informant 3*

An internal source like daydreaming or personal gadgets can be just as distracting as an external source like noise, visual stimuli, or peer interruptions (Alloway & Alloway, 2010). This finding indicates that even brief distractions, such as interruptions or multitasking, can significantly impair working memory performance and hinder learning outcomes.

A study by Junco and Cotton (2012) revealed that students who spent more time on Facebook had lower GPAs compared to those less frequent Facebook users. Accordingly, social media causes children to lose schoolwork focus and detrimentally affects their performance. Additionally, students who used Facebook for academic purposes saw reduced task perseverance, leading to a decline in productivity and educational outcomes (Kirschner & Karpinski, 2010).

4.3. On the Potential Solutions to Address the Identified Issues and Barriers in Science Education

Theme 1: Teacher Training and Development

Teacher training and development are vital aspects of enhancing the quality of science education in the Philippines. Teacher training and development initiatives encompass a range of activities, including workshops, seminars, conferences, and mentorship programs. These programs aim to address various

aspects of teacher preparation, such as content mastery, pedagogical techniques, classroom management, and the integration of technology into teaching practices. This theme focuses on strategies aimed at improving the preparation, proficiency, and ongoing professional development of science educators.

This theme is supported by the following excerpts from the responses:

"Exposing teachers to workshops, trainings, conferences, seminars, because all of this will allow them to continuously enhance and improve their knowledge and their skills, their approaches in teaching." Key Informant 1

"…training teachers on using basic laboratory apparatuses, as well as the availability of apparatuses in the classroom, with a ratio of one to one per student ideally, but then if not, well at least the student should be exposed to it…" Key Informant 2

"It would be really helpful to have training sessions and workshops where I can learn about new teaching methods, cool technology, and the latest science discoveries. Also, it would be great to talk and work with other teachers, both locally and from around the world, to get new ideas and resources." Key Informant 3

"…teachers should receive better training through ongoing professional development programs to stay updated on modern teaching methods and technology." Key Informant 3

The investigation's findings showed that better teaching tactics, more topic understanding, and better classroom management abilities result from high-quality teacher preparation, which encompasses both pre-service education and continuing professional development (Hyler et al., 2017).

Teacher preparation programs put a strong emphasis on giving educators the chance to expand their content and pedagogical skills and knowledge. Furthermore, to sustain and improve teaching practices over time, educators must get continual professional development aligned with their expertise and foster their continued progress.

It highlighted the favorable impact that well-planned and ongoing professional development helps teachers accommodate students' various needs in improving student motivation and accomplishment (Hyler et al., 2017)

Theme 2: Curriculum Enhancement

Curriculum enhancement is essential for modernizing and improving science education in the Philippines. This theme focuses on strategies aimed at revising and updating the science curriculum to align with contemporary educational standards, scientific advancements, and the needs of students.

This is supported by the following responses of the key informants:

"Teachers should be actively included in the development of curriculum guide, course outline, things like learning circles, so things like that." Key Informant 1

"The curriculum needs to be revamped to include more hands-on, inquiry-based learning approaches and align with global standards." Key Informant 3

The responses underscored the necessity of revamping the curriculum to incorporate more hands-on, inquiry-based learning approaches and ensure alignment with global educational standards. This reflects a shift towards more student-centered and interactive teaching methods that promote deeper understanding and engagement in science subjects. The updated curriculum can address the identified issues and barriers hindering quality science education by providing students with relevant and practical learning experiences aligned with contemporary educational practices and demands.

The research of Hattie et al. (2017) highlights the necessity to update and modify learning objectives, instructional materials, and assessment procedures to align with research-based methods, current standards, and student needs.

Students' enthusiasm and involvement in science can be increased by implementing curriculum innovations that relate science instruction to real-world situations and societal challenges (Osborne & Dillion, 2008].

Furthermore, compared to students in typical educational settings, Windschitl et al. (2008) discovered that students who received the enriched curriculum demonstrated higher interest, motivation, and active participation in science learning.

Theme 3: Program Restructuring

Program restructuring is a strategic approach to improving science education by reorganizing and optimizing existing educational programs and structures. This theme focuses on strategies aimed at streamlining and reconfiguring science education programs to enhance their effectiveness, efficiency, and relevance in meeting the needs of students and stakeholders.

This is supported by the following responses:

> *"This answer is very ambitious, but I think it's still restructuring the science education program in college and integrating those prerequisite courses in teaching higher mathematics and physics concepts. Because that would significantly enhance the program's effectiveness in creating or preparing future science educators." Key Informant 1*

> *"The best policy that could be implemented in order to strengthen science education is to have a good foundation on science concept. So it would be better if science is taught or strengthened earlier in the development stage of the students, and not just when they are in grade 3." Key Informant 2*

The responses underscored the significance of integrating prerequisite courses, such as higher mathematics and physics concepts, into science education programs to enhance their effectiveness in preparing future science educators. By aligning these prerequisite courses with teaching methodologies, educators can better equip students with the knowledge and skills needed to succeed in STEM-related fields.

Additionally, key informants stressed the importance of strengthening science education at the foundational stage of students' development, emphasizing the need to introduce science concepts earlier in the education process to provide students with a solid foundation in science from an early age, facilitating more profound understanding and long-term engagement with scientific principles.

Program restructuring poses a positive impact that offers a strategic pathway to address the identified issues and barriers in science education by enhancing the quality, relevance, and accessibility of science programs (Fullan, 2001). It frequently includes making revisions to instructional delivery methodologies and assessment protocols.

In addition, the National Science Foundation (2019) necessitates moving toward an integrated strategy that prioritizes scientific methods to bring science education into line with best practices and current research the programs

Further, Bybee (2013) found that program restructuring in scientific education successfully raised student learning results. Students in the reorganized program showed superior conceptual knowledge and scientific inquiry skills over traditional programs.

Theme 4: Resource Provision

Resource provision is critical for supporting effective science education delivery and promoting meaningful learning experiences for students. This theme focuses on strategies aimed at ensuring adequate access to resources, materials, and facilities necessary for high-quality science instruction in schools and educational institutions.

This theme is supported by the following excerpt:

> *"Schools must also be equipped with adequate resources, such as laboratories and textbooks, and efforts should be made to address teacher shortages, especially in rural areas." Key Informant 3*

The study of Hyler et al. (2017) discovered a substantial link between having enough resources and getting good grades. In addition, science teachers should have access to quality-assured learning and

teaching resources as well as continual professional development opportunities to improve their pedagogical skills, knowledge, and content expertise (OECD, 2010)

Additionally, Banilower et al. (2013) discovered that student progress in science was positively impacted by having access to top-notch teaching resources and materials.

Theme 5: Promotion of STEM Education

STEM (Science, Technology, Engineering, and Mathematics) education plays a crucial role in preparing students for success in the 21st century. This theme focuses on strategies aimed at promoting STEM education and fostering interdisciplinary learning experiences that integrate science, technology, engineering, and mathematics concepts and skills.

This is supported by the following excerpt of the responses:

> *"Promoting STEM education, fostering community engagement, and implementing evaluation and monitoring mechanisms are also crucial steps to enhance the overall quality of science education. Through these initiatives, students can gain the knowledge and skills needed to thrive in today's rapidly advancing world." Key Informant 3*

Through STEM education initiatives, students can develop the essential skills and competencies needed to succeed in a technology-driven society, such as digital literacy, computational thinking, and scientific inquiry skills. Through promoting STEM education, stakeholders can empower students to become lifelong learners and active contributors to the advancement of science and technology.

The promotion of STEM education is prevalent in educational studies. Irrespective of the type of career a student desires to pursue, STEM literacy is critical because it fosters transferable skills that can be utilized in a variety of sectors (National Science Foundation, 2019). A positive attitude toward STEM and addressing gender and diversity gaps in STEM fields are crucial. Student connections, experience, and skills can be gained through working with businesses, research institutions, and community organizations (Ministry of Education Singapore, 2018).

5. CONCLUSION

Secondary science teachers acknowledge several positive developments in science education, particularly the noticeable increase in student interest and engagement. Factors such as rising enrollment in STEM programs and active participation in science fairs reflect a growing enthusiasm for science-related disciplines among students. Additionally, there is a heightened awareness of the importance of science research literacy, with many schools engaging actively in scientific exploration.

However, significant barriers continue to impede the attainment of high-quality science education in the Philippines. These challenges are largely rooted in teacher-related factors, including insufficient preparation and training, which undermine the effective delivery of science instruction. Furthermore, foundational gaps in students' comprehension and limited conceptual understanding of scientific principles present formidable obstacles. Ineffective teaching methods and lack of engagement contribute to less-than-optimal learning experiences, while resource constraints—such as inadequate laboratory facilities and equipment—hinder students' ability to engage deeply with the material. Large class sizes and time limitations further complicate matters, restricting individualized attention and comprehensive coverage of the science curriculum.

Moreover, the lack of professional development and support opportunities for teachers diminishes their capacity to improve instructional practices. Lastly, distractions from technology and competing subjects detract from students' focus on science education.

Looking ahead, future research could explore several areas that stem from the findings of this study. For instance, investigating the long-term impacts of increased STEM enrollment on student outcomes would provide valuable insights into the effectiveness of current initiatives. Additionally, examining the relationship between teacher training programs and student engagement levels could uncover strategies for enhancing instructional quality.

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