

Pedagogical Beliefs and Teaching Practices of High School Science Teachers

Michael B. Dizon

Iloilo State University of Fisheries Science and Technology Barotac Nuevo, 5007 Iloilo Philippines

DOI: <https://doi.org/10.56293/IJMSSSR.2026.6233>

IJMSSSR 2026
VOLUME 8
ISSUE 3 MAY - JUNE

ISSN: 2582 – 0265

Abstract: This survey-correlational research was conducted to determine the pedagogical beliefs and teaching practices of 31 public high school science teachers in the Municipality of Barotac Nuevo, Province of Iloilo, Philippines. Additionally, it identified if significant difference exists in the pedagogical beliefs and teaching practices of science teachers when they are grouped according to sex, age, number of years in teaching science, and frequency with which science was taught. Moreover, this study also determined if there is a significant relationship between the pedagogical beliefs and teaching practices of science teachers. The participants were selected using census or a full population sampling technique. The statistical tools used in the study were frequency count, mean, standard deviation, Mann-Whitney U test, Kruskal Wallis H test, and Spearman correlation coefficient. All inferential tests were set at .05 level of significance. The results showed that the levels of pedagogical beliefs of science teachers as a whole and in terms of direct transmission beliefs and constructivist beliefs were high. Further, the levels of direct transmission beliefs and constructivist beliefs of science teachers when grouped as to sex, age, number of years in teaching science, and frequency with which science was taught were high. Moreover, the levels of teaching practices of science teachers as a whole and in terms of data collection and analyses, critique, argumentation, and explanation, modelling, traditional instruction, and prior knowledge were high, while in terms of instigating and investigation was moderate. In addition, the levels of teaching practices of science teachers in terms of data collection and analyses, critique, argumentation, and explanation, modelling, traditional instruction, and prior knowledge when grouped as to sex, age, number of years in teaching science, and frequency with which science was taught were high, while in terms of instigating and investigation was moderate. The results also showed that there is a significant difference in the direct transmission beliefs of science teacher when grouped as to age; however, there is no significant difference when grouped as to sex, number of years in teaching science, and frequency with which science was taught. Further, there is no significant difference in the constructivist beliefs of science teacher across all demographic factors. Also, there is a significant difference in the teaching practices of science teachers in terms of data collection and analyses when grouped as to sex; however, there is no significant difference when grouped as to age, number of years in teaching science, and frequency with which science was taught. Moreover, there is no significant difference in the teaching practices of science teachers in terms of critique, argumentation, and explanation, modelling, traditional instruction, and prior knowledge across all demographic factors. Lastly, there is a significant relationship between pedagogical beliefs as a whole and teaching practices as a whole of science teachers. Specifically, the categories of pedagogical beliefs and teaching practices with significant relationship were direct transmission beliefs and instigating and investigation, direct transmission beliefs and modelling, direct transmission beliefs and traditional instruction, direct transmission beliefs and prior knowledge, and constructivist beliefs and traditional instruction.

Keywords: pedagogical beliefs, teaching practices, high school science teachers, Iloilo, Philippines

Introduction

Science is the greatest achievement of human civilization and the driving force behind technical innovation and progress. The first three industrial revolutions that had previously occurred clearly defined this. The foundation of a more developed way of life and human civilization are greatly impacted by the emergence of new technology. The improvement of our local and global communities is significantly impacted by science education. As a result,

numerous nations are making significant investments in research and technology (Ligado, Guray, and Bautista, 2022).

Complex and advanced sciences are built on the foundation of elementary science. Their everyday activities with completing assignments and resolving issues are where this education starts. Learning becomes more interesting when real-world scenarios are present to deal with and natural phenomena are studied through experimentation, direct observation, and other methods. As a result, teachers and students alike gain new skills (Cherry, 2019).

In the Philippines, most proponents of increasing the science course work argue on the basis of the assumption that one cannot teach what one does not understand. Science teachers need to develop pedagogical beliefs related to teaching and learning practices known to be associated with better student learning. Research has shown that these pedagogical beliefs guide how teachers plan for their classroom activities and shape the teachers' cognitions and behaviors while in the classroom. But teacher beliefs are often unconscious, stable and resistant to change. It is not surprising therefore, that many advocates of teacher development have emphasized the need to focus on teacher beliefs in the processes of educational reforms. This push has certainly applied to the area of science education reform.

This research confronts a pressing issue regarding the pedagogical beliefs of science teachers in the Philippines, particularly how these beliefs influence teaching practices and student learning outcomes. There is a lack of research on the specific connection between teachers' beliefs and the current basic science education curriculum. Additionally, there is a need for more studies that examine the challenges and opportunities for teachers to adapt their pedagogical beliefs to the evolving needs of the science curriculum and the diverse student population.

In educational settings, pedagogical belief is defined as "one's convictions, philosophy, tenets, or opinions about teaching and learning." Teacher beliefs about learning and teaching have been found to shape teachers' practices; this means that the concept of pedagogical belief is tied up with specific teaching practices. The teacher's pedagogical beliefs, which influences their pedagogical reasoning, are essential determinants of the learning outcomes, and therefore necessitates that teachers need to undertake more pedagogical reasoning in the planning of their assessment for learning activities in order to integrate adopt and use appropriate assessment tools and methods. Furthermore, literature showed that employing different assessment of learning formats (Sari et al., 2020) springs from the belief and knowledge of the learners' different learning styles (Kanli and Ilican, 2020).

Furthermore, this study situates itself in the author's environment, backed by local information, studies, and surveys conducted by other researchers. The researcher recognizes that science teachers require targeted professional development and a shift in teaching practices. This includes fostering awareness of their own beliefs, encouraging reflection on teaching practices, and implementing strategies that align with contemporary science education principles.

According to Namoco and Zaharudin (2021), investigations specifically concerning what drive the teacher to choose certain assessment strategy to measure students' learning, specifically in a science class seem limited. It is therefore the purpose of this study to explore and make sense of the teacher's pedagogical belief regarding their assessment for learning practices in their teaching-learning work.

Several justifications guide the choice of this research topic. Firstly, there is a glaring gap in knowledge about the relationship between teachers' beliefs and their actual teaching practices, particularly in light of the shift towards inquiry-based and hands-on science teaching. Additionally, research is needed on the impact of limited resources and infrastructure on teachers' ability to implement effective science instruction, and how this impacts student learning. Secondly, the study seeks to effectively research on teacher beliefs in the context of science educational reform by focusing on the nature of those beliefs, their formation, and how they influence teaching practices or by exploring the relationship between teachers' beliefs about science, teaching, and learning, and how these beliefs align with or conflict with reform goals.

The necessity of this study is evident in its potential to determine how pedagogical beliefs influence teaching decisions, the challenges teachers face in adapting to new approaches, and the strategies that support positive change; and to explore how to effectively support teachers in developing the knowledge, skills, and resources necessary to meet the diverse needs of students.

This study considered two primary variables: pedagogical beliefs and teaching practices of science teachers. To guide the researcher in exploring these variables, the researcher anchors this study within the framework that often involves examining how a teacher's beliefs about teaching and learning influence their classroom actions. This framework typically involves collecting data on teachers' beliefs, observing their teaching practices, and analyzing the relationships between these two areas.

This study is grounded on the Theory of Reasoned Action which emphasizes that a person's behavior is determined by attitude toward a behavioral outcome and public opinion. This theory was coined by Fishbein and Ajzen (1975) saying that behavior is influenced by intention to shape the behavior and the intention is a function of attitude of behavior and subjective norm. The second theory that informs this study is the constructivist philosophy of teaching and learning. The constructivist theory asserts that individuals' actions are mainly shaped by their beliefs, which are derived from their earlier experiences (Yesilyurt, 2022). Likewise, teachers who enter teacher training programs with established beliefs about teaching and learning, have been influenced and shaped mainly by their previous schooling experiences. The third and final theory supporting this study is Social Theory which plays a significant role in shaping the pedagogical beliefs and teaching practices of science teachers, influencing how they view learning, teaching, and the role of social interactions in the classroom. These beliefs, in turn, influence the strategies they use to teach science. Social Theory provides a framework for understanding how teachers' beliefs and practices are influenced by social, cultural, and environmental factors, and how these factors can be leveraged to improve science education.

Together, these theories create a robust foundation for this research, grounding the study in well-established principles and widely accepted educational concepts. This study aimed to determine the pedagogical beliefs and teaching practices of science teachers in public high schools in the Municipality of Barotac Nuevo, Province of Iloilo for the school year 2024-2025. Specifically, this study sought to answer the following: (1) What is the level of pedagogical beliefs of science teachers as a whole and in terms of direct transmission beliefs and constructivist beliefs? (2) What is the level of pedagogical beliefs of science teachers in terms of direct transmission beliefs and constructivist beliefs grouped according to sex, age, number of years in teaching science, and frequency with which science was taught? (3) What is the level of teaching practices of science teachers as a whole and in terms of instigating and investigation; data collection and analyses; critique, argumentation, and explanation, modelling; traditional instruction; and prior knowledge? (4) What is the level of teaching practices of science teachers in terms of instigating and investigation; data collection and analyses; critique, argumentation, and explanation, modelling; traditional instruction; and prior knowledge when grouped according to sex, age, number of years in teaching science, and frequency with which science was taught? (5) Are there significant differences in the pedagogical beliefs of science teachers in terms of direct transmission beliefs and constructivist beliefs when grouped according to sex, age, number of years in teaching science, and frequency with which science was taught? (6) Are there significant differences in the teaching practices of science teachers in terms of instigating and investigation; data collection and analyses; critique, argumentation, and explanation, modelling; traditional instruction; and prior knowledge when grouped according to sex, age, number of years in teaching science, and frequency with which Science was taught? (7) Is there a significant relationship between the pedagogical beliefs and teaching practices of science teachers?

Methodology

A survey-correlational research design was utilized for this study. The participants selected for this study were the thirty-one (31) permanent science teachers currently employed in all public high schools in the Municipality of Barotac Nuevo, Province of Iloilo. The participants were selected using census or a full population sampling technique. These teachers play a pivotal role in shaping the understanding and perspectives of students in science curriculum within the basic education system. Focusing on permanent science teachers in a study about pedagogical beliefs and teaching practices allows researchers to explore the long-term impact of these beliefs on

their teaching, as well as to understand how these beliefs evolve over time in a stable work environment. Additionally, permanent teachers may be more likely to have developed a consistent teaching style and philosophy, providing a clearer picture of the relationship between beliefs and practice.

The participants were chosen using census or a full population sampling technique. A census is an attempt to list all elements in a group and to measure one or more characteristics of those elements. It can provide detailed information on all or most elements in the population, thereby enabling totals for rare population groups or small geographic areas.

The research questionnaire for this study encompasses two key dimensions: pedagogical beliefs and teaching practices. The first part of the instrument was used to gather the personal data of the participants, the second part was used to gather data on the pedagogical beliefs, and the third part was used to gather information on the teaching practices of science teachers.

Pedagogical Beliefs. An 8-item adopted Teaching and Learning International Survey (TALIS) questionnaire based from the concept of Gillece (2012) was used. TALIS is a project of the Organization for Economic Cooperation and Development (OECD) that placed significant emphasis on teachers' pedagogical beliefs as a crucial aspect of the survey. It was developed as part of the OECD's work in the area of Indicators of Education Systems (INES) and arose, that there was a need for better national and international information on teachers. This instrument was divided into two areas: Direct Transmission Beliefs (items 1-4), and Constructivist Beliefs (items 5-8). As to the reliability of the Teaching and Learning International Survey (TALIS), the Cronbach's alpha value for a scale measuring pedagogical beliefs was found to be acceptable in most countries. However, due to measurement issues, this specific index was removed from TALIS 2018. Conversely, reliability ensures that the measures used in TALIS are consistent and dependable, allowing for valid comparisons of teaching and learning conditions across countries and over time.

Teaching Practices. To measure the teaching practices of science teachers, a 24-item adopted Science Instructional Practices Survey (SIPS) based from the work of Hayes, Lee, DiStefano, O'Connor, and Seitz, (2016) was used. This instrument is composed of six areas: instigating and investigation (items 1-4); data collection and analyses (items 5-9); critique, argumentation, and explanation (items 10-14); modelling (items 15-17); traditional instruction (items 18-21); and prior knowledge (items 22-24). The Science Instructional Practices Survey (SIPS) is a new, short survey tool designed to document shifts in 3rd-10th grade teacher instructional practice towards practices aligned with the Next Generation Science Standards (NGSS). Such assessment is important to document progress and guide future decisions regarding the efforts involved in shifting to new standards. The SIPS improves on existing survey instruments by identifying a broad range of instructional practices that support student inquiry in science, as well as communication and critical thinking skills. This survey instrument highlights key shifts in teaching and learning that are central to the design of the NGSS and similar new science standards being adopted by states and throughout the country. According to Hayes, Lee, DiStefano, O'Connor, & Seitz, (2016), the questionnaire involved validation through expert review and teacher cognitive interviews. The 31-item survey was then tested with 3rd through 10th grade science teachers (397) taking part in National Science Foundation (NSF)-funded professional development focused on improving science content and implementing Next Generation Science Standards (NGSS). Its construct validity was assessed through Exploratory Factor Analysis (EFA). The emergent factors were then tested for validity through confirmatory factor analysis (CFA) with an independent sample; the six-factor model met all Goodness of Fit indices. Reliability was established through internal consistency; all factors exhibited moderate to high internal consistency (Cronbach's alpha = .80-.88). Finally, evidence for criterion validity was generated through correlations between teacher hours of NGSS PD participation and school demographics (Free and Reduced Lunch, accountability profile) in accordance with the literature. Instrument reliability is the extent to which an instrument consistently measures what it is supposed to measure (Calmorin, 2012). A computed reliability coefficient of .80 but not more than 1.00 is necessary to establish the reliability of a research instrument.

The descriptive statistical tools utilized in this study were frequency count, mean, and standard deviation. The inferential statistics were Mann-Whitney U test, Kruskal Wallis H test, and Spearman correlation coefficient. The alpha level of significance was set at 0.05.

Results and Discussion

Pedagogical Beliefs of Science Teachers

The result on the level of pedagogical beliefs as a whole and in terms of direct transmission beliefs and constructivist beliefs is shown in Table 1. Data revealed that in its entirety, teachers who are teaching science in all public high schools in the Municipality of Barotac, Province of Iloilo have high level of pedagogical beliefs (M = 3.61, SD = 0.23). The categories under pedagogical beliefs have high results as follows: direct transmission beliefs (M = 3.58, SD = 0.31); and constructivist beliefs (M = 3.65, SD = 0.34).

Table 1 Mean and Standard Deviation of Pedagogical Beliefs of Science Teachers as a Whole and in Terms of Direct Transmission Beliefs and Constructivist Beliefs

| <i>Variable</i> | <i>Mean</i> | <i>Description</i> | <i>SD</i> |
|---|-------------|--------------------|-----------|
| Pedagogical Beliefs of Science Teachers | 3.61 | High | 0.23 |
| Direct Transmission Beliefs | 3.58 | High | 0.31 |
| Constructivist Beliefs | 3.65 | High | 0.34 |

| Score | Description |
|-------------|----------------|
| 3.25 – 4.00 | High |
| 2.50 – 3.24 | Moderate High |
| 1.75 – 2.49 | Moderately Low |
| 1.00 – 1.74 | Low |

The result from Table 1 shows that the Science teachers in all public high schools in the Municipality of Barotac, Province of Iloilo have a high level of pedagogical beliefs. The result across all categories suggests that Science teachers have a strong foundation for effective teaching practices. This could lead to increased student engagement, better learning outcomes, and a more positive learning environment for all students. However, it also raises questions about the potential for homogenization of teaching methods and the need for ongoing professional development to ensure teachers stay current with the latest research and adapt their practices to diverse student needs.

This high level of direct transmission beliefs would suggest a widespread tendency for teachers to prioritize knowledge transmission over student engagement and inquiry-based learning. This could lead to several negative implications for student learning and science education. A focus on direct transmission often involves lectures and rote memorization, which can lead to students becoming passive recipients of information rather than active learners. When teachers primarily focus on delivering information, students may not be as encouraged to explore, question, and actively construct their own understanding of scientific concepts. Moreover, direct transmission models often neglect opportunities for students to practice critical thinking, problem-solving, and scientific reasoning through hands-on investigations and experiments. Students may struggle to grasp complex scientific concepts and make connections between abstract ideas if they are not actively involved in the learning process. Students who are only taught to memorize information may have difficulty applying their knowledge to real-world situations or adapting their understanding to new contexts. Additionally, teachers who strongly hold direct transmission beliefs may be resistant to adopting more student-centered, inquiry-based teaching approaches. Furthermore, direct transmission models might make it challenging for teachers to effectively implement inquiry-based curricula that emphasize student exploration and collaboration.

On the other hand, this study revealed that all public high school science teachers embraced high constructivist beliefs that would likely lead to several positive implications for student learning, teacher practice, and the overall science education landscape. These include improved student engagement, deeper understanding of scientific concepts, and more personalized learning experiences.

This high level of constructivist beliefs of science teachers shows that they highly prioritize student-centered learning, encourage active participation through inquiry, exploration, and experimentation. This would lead to greater engagement, help students connect new information to their existing knowledge, and a deeper and more meaningful understanding of science concepts. This would also promote critical thinking skills and allow students to think independently and develop their own perspectives, rather than passively receiving information.

Furthermore, a high level of belief in constructivism of science teachers indicates a commitment to ongoing professional development, as they seek to refine their skills and explore new teaching methods. They are more likely to embrace innovation and adapt their practice to better meet the needs of their students. This also demotes collaboration with colleagues and reflection on their teaching practices to improve student outcomes.

Lastly, since all public high school science teachers in the Municipality of Barotac, Province of Iloilo hold both high constructivist and direct transmission beliefs, it could lead to a more balanced and nuanced approach to teaching, potentially improving student engagement and learning outcomes. The challenges would lie in finding ways to effectively integrate these seemingly opposing beliefs into practice.

The results support the development of a new theory called “Balanced Pedagogy” (BP). This theory suggests that effective science teaching requires a conscious blending of student-centered constructivist approaches with teacher-directed direct instruction strategies. In this study, teachers exhibited “high pedagogical beliefs,” holding both high constructivist and direct transmission beliefs, reflecting their balanced or potentially diverse approach to teaching, rather than a monolithic one. It indicates that science teachers likely incorporate both student-centered, inquiry-based learning and more traditional, teacher-led instructional methods.

This contradicts the Constructivist theory, which supports the notion that science teachers should view their role as facilitators of learning, guiding students in actively constructing their own understanding of science concepts rather than passively receiving information. This means teachers should create environments that encourage exploration, inquiry, and collaboration, allowing students to build upon their prior knowledge and experience (Yesilyurt, 2022). If all teachers hold high beliefs in both constructivism and direct transmission, it implies a potential tension. Constructivist theory suggests that teachers should be facilitators, not simply transmitters of information. Teachers might hold both beliefs simultaneously, viewing direct transmission as a necessary component alongside constructivist approaches. Some teachers may be trained in both constructivist and direct instruction methods, leading to a blended approach. Teachers’ beliefs about teaching and learning may evolve over time, leading to shifts in how they implement different pedagogical approaches.

The finding aligns with Macugay (2002) which determines the pedagogical beliefs of science teachers. The result showed that high school Science teachers tend to adhere more to Learning support Model which denotes resources, strategies, and practices that provide support to learners beyond the formal curriculum, aiming to help students succeed in their education.

However, this finding contradicts Haatainen, Turkka and Aksela, (2021) which show that teachers regarded integrated science education (ISE) as a relevant teaching method, but challenging to implement, and teachers primarily applied integrated approaches irregularly and seldom. The researchers indicate that teachers need support to better understand and implement ISE.

It also contradicts Luft, Navy, Wong, and Hill (2022) which examined the beliefs and practices of secondary science teachers over a 5-year period. The results highlighted the difficulty in changing the instruction of the teachers, administrative decisions that constrained or contributed to the learning of the new teachers, and the different professional learning opportunities new teachers drew upon over time. Their results suggest that early professional development experiences provided some support for the newly hired teachers, but not enough to challenge their beliefs or establish the instructional repertoires envisioned in the science education reforms.

Pedagogical Beliefs of Science Teachers in Terms of Direct Transmission Beliefs when Grouped as to Sex, Age, Number of Years in Teaching Science, and Frequency with which Science was Taught

The results showed that the level of pedagogical beliefs of science teachers in terms of direct transmission beliefs when grouped as to sex, age, number of years in teaching science, and frequency with which science was taught is high. This underscores that teachers primarily view their role as presenting knowledge to students who passively absorb it. This also characterizes that science teachers are active transmitters and the students as passive recipients of knowledge in science education.

The findings do not align with Arif and Nawaz (2020) that male science teachers tend to engage more than their female counterparts and teachers with over 20 years of teaching experience demonstrate greater implementation of pedagogical beliefs during classroom instruction compared to other teachers.

This comprehensive understanding of pedagogical beliefs of high school science teachers helps to identify the underlying principles that guide their teaching practices, which in turn influences student learning and engagement. By understanding these beliefs, educators can better support teachers in implementing effective teaching strategies and fostering a more engaging learning environment for students. By recognizing these beliefs, educators can more effectively assist teachers in synchronizing their methods with successful science education principles and tackle possible challenges in their instruction. Overall, grasping the educational beliefs of science educators is essential for enhancing science education quality and guaranteeing that every student can learn and interact with science successfully.

Pedagogical Beliefs of Science Teachers in Terms of Constructivist Beliefs when Grouped as to Sex, Age, Number of Years in Teaching Science, and Frequency with which Science was Taught

The results also showed that the level of pedagogical beliefs of science teachers in terms of constructivist beliefs when grouped as to sex, age, number of years in teaching science, and frequency with which science is high. This high level of constructivist pedagogical beliefs among science teachers in all public high schools in the Municipality of Barotac, Province of Iloilo, regardless of their age, suggests a consistent and positive approach to teaching across different age groups within the teaching staff. This is beneficial for student learning as constructivism promotes active participation, exploration, and meaning-making, leading to deeper understanding. This finding suggests that age does not significantly influence a teacher's inclination towards constructivist teaching practices. This finding further suggests that the teachers, whether young or old, are generally aligned with the principles of constructivism. This could be due to factors like professional development, training, or a shift in educational philosophies.

The study of Chen, Hong, Ye, and Ho (2022) on the role of teachers' constructivist beliefs in classroom observations based on a social cognitive theory perspective, showed that teachers' constructivist belief in teaching was positively related to perceived value of being observed and getting feedback, but was negatively related to psychosocial stress. Perceived value was positively related to continuous intention to be observed in future classroom observations, but perceived psychosocial stress was not significantly related to continuous intention. The results of this study can be applied to encourage those who are resistant to presenting their teaching experience in classroom observations.

Teaching Practices of Science Teachers

The result on the level of teaching practices of science teachers as a whole and in terms of instigating and investigation; data collection and analyses; critique, argumentation, and explanation; modelling; traditional instruction; and prior knowledge is shown in Table 2. Data revealed that in its entirety, teachers who are teaching science in all public high schools in the Municipality of Barotac, Province of Iloilo have high level of teaching practices ($M = 3.64$, $SD = 0.73$).

The categories under teaching practices have high results as follows: data collection and analyses ($M = 3.66$, $SD = 0.76$); critique, argumentation, and explanation ($M = 3.74$, $SD = 0.88$); modelling ($M = 3.44$, $SD = 0.80$); traditional instruction ($M = 3.77$, $SD = 0.86$); and prior knowledge ($M = 3.90$, $SD = 1.00$) except for instigating and investigation with moderate result ($M = 3.32$, $SD = 0.73$).

Table 2 Mean and Standard Deviation of Teaching Practices of Science Teachers as a Whole and in terms of Instigating and Investigation, Data Collection and Analyses, Critique, Argumentation, and Explanation, Modelling, Traditional Instruction, and Prior Knowledge

| <i>Variable</i> | <i>Mean</i> | <i>Description</i> | <i>SD</i> |
|--|-------------|----------------------|-----------|
| Teaching Practices | 3.64 | Highly Practiced | .73 |
| Instigating and Investigation | 3.32 | Moderately Practiced | .73 |
| Data Collection and Analyses | 3.66 | Highly Practiced | .76 |
| Critique, Argumentation, and Explanation | 3.74 | Highly Practiced | .88 |
| Modelling | 3.44 | Highly Practiced | .80 |
| Traditional Instruction | 3.77 | Highly Practiced | .86 |
| Prior Knowledge | 3.90 | Highly Practiced | 1.00 |

| Score | Description |
|-------------|-----------------------|
| 4.21 – 5.00 | Very Highly Practiced |
| 3.41 – 4.20 | Highly Practiced |
| 2.61 – 3.40 | Moderately Practiced |
| 1.81 – 2.60 | Less Practiced |
| 1.00 – 1.80 | Not Practiced |

The result from Table 2 shows that the Science teachers in all public high schools in the Municipality of Barotac, Province of Iloilo have a high level of teaching practices ($M = 3.64$, $SD = 0.73$). The result across all categories except for instigating and investigation suggests significant positive implications for student learning, academic achievement, and school culture. Students would likely experience improved understanding of scientific concepts, enhanced critical thinking skills, and a greater appreciation for science, leading to increased engagement and motivation in learning. The widespread adoption of high teaching practices in public high school science classrooms would have a profound and positive impact on students, teachers, and the broader school community. By fostering a love of science, developing critical thinking skills, and creating a supportive learning environment, high teaching practices can empower students to reach their full potential and make significant contributions to society.

However, all public high school science teachers adopted moderate teaching practices in terms of instigating and investigation ($M = 3.32$, $SD = 0.73$), it could lead to a more inquiry-based and hands-on learning experience for students, potentially boosting their engagement and scientific understanding. However, it could also mean that some students may not have the same level of support for learning, and teachers might find it challenging to manage the diverse learning styles and needs of all students within their classrooms.

Data collection and analyses is “Highly Practiced” ($M = 3.66$, $SD = 0.76$) by all public high school science teachers and it would likely lead to improved student learning, more effective instruction, and a more personalized learning experience. Teachers could use data to tailor their instruction, identify areas where students are struggling, and make informed decisions about their teaching. This approach could also lead to greater teacher collaboration and professional development, as they share data and insights to improve their practices.

Additionally, critique, argumentation, and explanation are “Highly Practiced” ($M = 3.74$, $SD = 0.88$) by science teachers that point to several positive outcomes such as enhanced student understanding of scientific concepts, improved critical thinking skills, and greater engagement with science content. Argumentation also supports the development of effective communication and collaborative learning, leading to more meaningful learning experiences.

Furthermore, modelling is “Highly Practiced” ($M = 3.44$, $SD = 0.80$) by science teachers and this suggests significant benefits for student learning, engagement, and understanding of scientific concepts. It would lead to improved comprehension of abstract ideas, enhanced scientific skills, and a deeper appreciation for the nature of science. Furthermore, it could foster a more dynamic and engaging learning environment, potentially increasing student motivation and interest in STEM fields. This further implies a more engaging, effective, and scientifically literate student population.

Moreover, traditional instruction is “Highly Practiced” ($M = 3.77$, $SD = 0.86$) by science teachers and this underscores lower student engagement, reduced critical thinking skills, and a less effective understanding of scientific concepts. However, some studies also indicate that traditional methods can be effective in certain contexts, particularly for subjects like math and physics. Traditional lecture-style teaching can be less engaging for students, potentially leading to disinterest and lower levels of participation. Students may struggle to apply their knowledge to real-world scenarios if they are primarily exposed to traditional instruction, which often focuses on theoretical concepts rather than practical applications. In today’s rapidly changing educational landscape, relying heavily on traditional methods may make it difficult for teachers to adapt to new technologies and learning approaches.

Lastly, Prior Knowledge is “Highly Practiced” ($M = 3.77$, $SD = 0.86$) by science teachers and this suggests enhanced student engagement, improved learning outcomes, and better knowledge retention. By understanding and building upon what students already know, teachers can create more meaningful and relevant learning experiences. Activating prior knowledge helps students connect new information to their existing understanding, making it more memorable and relevant. This can lead to increased student engagement and motivation. When teachers understand and address misconceptions or knowledge gaps based on prior knowledge, students can develop a more accurate and deeper understanding of scientific concepts.

If all categories of teaching practices are highly implemented by public high school science teachers, except for instigating and investigation, the results support the development of a new theory called “Over-reliance on Direct Instruction and Content Mastery.” This theory suggests that teachers primarily focus on delivering content, assessing knowledge, and emphasizing factual recall, potentially neglecting active learning, inquiry, and deeper engagement with scientific concepts.

According to the Theory of Reasoned Action (TRA), a person’s behavior is determined by their intention to perform that behavior, which is influenced by their attitude towards the behavior and subjective norms (Fishbein and Ajzen, 1975). If all public high school science teachers highly practice teaching practices across all categories except for instigating and investigation, it could potentially contradict the TRA if their intention to practice these specific categories is low due to negative attitudes or subjective norms associated with them, even if they are highly practicing other teaching methods.

According to Bibon (2022), even though the instructional practices of science teachers emphasize the use of differentiation for planning, spiralling and inquiry in the delivery, and product-focused and differentiation in assessment, the academic achievement of learners across all curricular programs in science was below the expected standards of the national policy indicating that learning is not at par with the prospects of Philippine K-12 curriculum as teachers were not proficient enough in applying K-12 curriculum instructional practices to enhance the academic achievement of learners.

Rapanta et al. (2021) say that the shift in learning modalities worldwide, prompting modifications and revaluations of educational practices in the Philippines. The emergence of various educational technologies has reshaped teaching practices, replacing outdated methods with more efficient and effective tools. The advancement of technology has allowed teachers to explore various teaching practices to facilitate an effective teaching and learning process (Bibi et al., 2024; Murtaza et al., 2024; O’Connor and Natividad, 2023). The emergence of various software and applications also serves as an aid to efficiently and effectively facilitate learning (Cadiz et al., 2024). With this premise, there is a need for science teachers to participate in ICT-based seminars in science, and paralleling instructional planning, delivery, and assessment practices (Bibon, 2022).

This result also supports Chan et al. (2020) which revealed that teachers’ practices of planning learning episodes elicit active engagement as evidence of meaning making. Various learning activities have been conceptualized to thoroughly activate prior knowledge on essential information and concepts and link these to new knowledge being introduced in the lesson through designed activities.

Teaching Practices of Science Teachers in Terms of Instigating and Investigation when Grouped as to Sex, Age, Number of Years in Teaching Science, and Frequency with which Science was Taught

The results showed that the level of teaching practices of science teachers in terms of instigating and investigation when grouped as to sex, age, number of years in teaching science, and frequency with which science was taught is high. This finding supports that of Baniqued and Bautista (2024) on teachers' preparedness on pedagogical practices in k-12 science education, who investigate the implications and future works to bolster the preparedness of teachers to pedagogical practices in science teaching. The results indicate a sub-optimal level of preparedness among respondents, highlighting significant gaps in their pedagogical practices.

This finding also supports that of Bibon (2022) on teachers' instructional practices and learners' academic achievement in science, who revealed that the instructional practices of science teachers emphasize the use of differentiation for planning, spiralling and inquiry in the delivery, and product-focused and differentiation in assessment.

According to Bibon (2022), Philippines has been constantly battling to improve its academic achievement across major learning disciplines. Its academic achievement downfall was observed in many national and international assessments attributing the failure to its congested Basic Education Curriculum (BEC) with numerous competencies to be learned in limited time frame. As a support, science teachers may be encouraged to utilize instigating and investigation teaching practices, like inquiry-based learning to significantly boost student academic achievement. These approaches encourage students to actively explore concepts, make discoveries, and become more invested in their learning process, leading to better retention and application of knowledge.

Teaching Practices of Science Teachers in Terms of Data Collection and Analyses when Grouped as to Sex, Age, Number of Years in Teaching Science, and Frequency with which Science was Taught

The results showed that the level of teaching practices of science teachers in terms of data collection and analyses when grouped as to sex, age, number of years in teaching science, and frequency with which science was taught is high.

Baniqued and Bautista (2024) put in that the landscape of K–12 science education is marked by multifaceted challenges that significantly influence the quality and efficacy of teaching and learning. A fundamental challenge lies in developing a science curriculum that is both comprehensive and aligned with contemporary scientific advancements while remaining relevant and engaging for students. This requires curriculum alignment with national standards to enhance student engagement and understanding. Teacher preparedness and ongoing professional development stand out as critical areas requiring attention. Many educators encounter obstacles stemming from inadequate training, limited access to professional development opportunities, and a lack of deep content knowledge.

The result on the data collection and analysis which is more prevalent among female science teachers than male teachers could lead to improved student outcomes, more personalized instruction, and potentially a greater emphasis on research-informed teaching practices. This could also lead to a greater focus on addressing gender biases in science education and a more inclusive learning environment. When the data collection and analysis in science education are driven by female science teachers, who are often perceived as more likely to adopt these practices, they can improve student outcomes, personalize instruction, enhance their own effectiveness, and promote equity and inclusion in science education.

The result on the data collection and analysis which are highly practiced by science teachers, regardless of their experience or teaching load, could lead to improved student learning, more effective teaching practices, and better-informed decision-making at all levels, from individual classrooms to school districts. This is because data analysis helps teachers understand student strengths and weaknesses, tailor instruction, and monitor the impact of interventions. The widespread adoption of data collection and analysis in science education can be a powerful tool for improving teaching and learning, and for making more informed decisions about education at all levels.

According to Kolovou (2022), the fundamental science curriculum often fails to equip the increasing population with scientific literacy, as it typically relies more on straightforward lectures presenting factual information about scientific findings, requiring students to memorize these concepts. However, this fulfils the goal of science

education, as a scientifically literate person does not merely memorize ideas but can practically apply these scientific concepts, theories, terminology, methods, and similar elements (Rudolph, 2024). Science education must go beyond merely conveying facts and focus more on fostering scientific thinking, preparing students to become adults who innovatively solve various socio-scientific challenges they may face (McLure, Won, and Treagust, 2024; Willemsen, Vink, Kroesbergen, and Lazonder, 2023).

Teaching Practices of Science Teachers in Terms of Critique, Argumentation, and Explanation when Grouped as to Age, Sex, Number of Years in Teaching Science, and Frequency with which Science was Taught

The results showed that the level of teaching practices of science teachers in terms of critique, argumentation, and explanation when grouped as to sex, age, number of years in teaching science, and frequency with which science was taught is high. This finding supports the claim of Lin, Hmelo-Silver, and Lan (2019) and Anoling et al. (2024) that science education in primary and secondary schools plays a pivotal role in shaping the scientific understanding and critical thinking skills of students. Scholars argued that effective science education does not only foster essential skills for the workforce but also cultivate informed citizens capable of understanding and contributing to discussions on scientific issues. Integrating engineering practices that include identifying problems, designing solutions, and implementing those solutions into science education cultivate problem-solving skills. This integration emphasizes iterative problem-solving processes and fosters resilience in students when faced with complex challenges.

Teaching Practices of Science Teachers in Terms of Modelling when Grouped as to Sex, Age, Number of Years in Teaching Science, and Frequency with which Science was Taught

The results showed that the level of teaching practices of science teachers in terms of modelling when grouped as to sex, age, number of years in teaching science, and frequency with which science was taught is high. This finding supports that of Guansing and Natividad (2024), that practices of junior high school science teachers with over ten years of service revealed that personal values, where they model these values through their actions, words, and interactions with students and colleagues, inspiring students to develop positive values and behaviors, are central to upholding quality education. The study further highlights the participants' reflections on their pedagogical practices on their personal and professional lives.

Teaching Practices of Science Teachers in Terms of Traditional Instruction when Grouped as to Sex, Age, Number of Years in Teaching Science, and Frequency with which Science was Taught

The level of teaching practices of science teachers in terms of traditional instruction when grouped as to sex, age, number of years in teaching science, and frequency with which science was taught is high. This result supports the claim of Dasas (2020) that science education in the Philippines remains dominantly teacher-centered. Instruction primarily involves knowledge-transmission and does not involve inquiry-oriented activities nor encouragement of self-directed and effortful learning. Teaching practices significantly influence science education outcomes. Effective teachers, with diverse instructional methods and a strong understanding of the subject, can boost student learning and critical thinking skills. However, challenges like out-of-field teaching can hinder science education, particularly in rural areas.

This result also highlights the finding of Majo (2016), Blazar (2016) and Johnson (2017) that the factors affecting the poor performance of learners in science include poor teaching methods. The lack of pedagogical skills of teachers significantly affects learning. Whichever is the reflection of the truth whether it is the lack of teaching competence or the hard nature of the science subject itself that contribute to poor academic performance, reports have shown that academic achievement has something to do with teaching practices.

The higher the qualification level of science teachers and quality teacher readiness, the higher the student achievement. Improving the standard of science instruction necessitates focusing on teachers whose perspectives are integral to enhancing education quality. Experienced teachers bring valuable insights into the profession, shaped by their practices. Teachers' practices are essential factors that influence the effectiveness of teaching and learning (Kwak, 2019).

Teaching Practices of Science Teachers in Terms of Prior Knowledge when Grouped as to Sex, Age, Number of Years in Teaching Science, and Frequency with which Science was Taught

The level of teaching practices of science teachers in terms of prior knowledge when grouped as to sex, age, number of years in teaching science, and frequency with which science was taught is high. This finding supports that of Chan et al. (2020) on how the theory of constructivism has been translated into pedagogical practices of science teachers among the selected schools in Metro Manila, who uncovered that teachers' practices involve various learning activities have been conceptualized to thoroughly activate prior knowledge on essential information and concepts and link these to new knowledge being introduced in the lesson through designed activities.

Differences in the Pedagogical Beliefs of Science Teachers as a whole and in terms of Direct Transmission Beliefs, and Constructivist Beliefs when grouped as to Age, Sex, Number of Years in Teaching Science, and Frequency with which Science was Taught

There is a significant difference in the direct transmission beliefs of science teacher when grouped as to age; however, there is no significant difference when grouped as to sex, number of years in teaching science, and frequency with which science was taught. Further, there is no significant difference in the constructivist beliefs of science teacher across all demographic factors. The result shows that sex and teaching frequency do not drastically influence how teachers perceive or prioritize direct instruction methods. This could imply that factors beyond gender or teaching experience, like individual beliefs, professional development, or school environment, are more influential. This could mean that teachers, regardless of their sex or teaching frequency, generally hold similar beliefs about the role and effectiveness of direct instruction. Even without significant differences, it is important to explore other potential factors influencing beliefs, such as experience level, educational background, or school culture. If beliefs are largely consistent, training programs can focus on improving specific aspects of direct instruction, rather than addressing perceived gender or experience-based differences.

This result supports Kirkiç and Yahşi (2021), who determined the relationship between secondary school science teachers' views on student achievement and learning and their own level of teaching motivation. The findings showed that there was no difference according to gender variable. The result contradicts Ambusaidi and Al-Maqbali (2022), who said that the success of an educational process is represented by success in making appropriate decisions. Their study explored the pedagogical decision-making by science teachers in dealing with pedagogical issues based on their point of views. The results of the study indicated a statistically significant difference in some options in favor of female teachers. This finding does not align with Shaukat, Vishnumolakala, and Hamdan Alghamdi (2020), who explored science teachers' perceptions of personal science efficacy beliefs and science teaching in Saudi Arabia, Pakistan, and the United Arab Emirates. The results revealed statistically significant differences among teachers from the three countries on both subscales. Similarly, there were statistically significant gender differences among teachers in their science efficacy beliefs. This result does not support Shaukat, Vishnumolakala, & Hamdan Alghamdi (2020), who explored science teachers' perceptions of personal science efficacy beliefs and science teaching in Saudi Arabia, Pakistan, and the United Arab Emirates. The results revealed statistically significant differences among teachers from the three countries on both subscales. Similarly, there were statistically significant gender differences among teachers in their science efficacy beliefs.

Differences in the Teaching Practices of Science Teachers as a whole and in terms of Instigating and Investigation, Data Collection and Analyses, Critique, Argumentation, and Explanation, Modelling, Traditional Instruction, and Prior Knowledge when grouped as to Age, Sex, Number of Years in Teaching Science, and Frequency with which Science was Taught

There is a significant difference in the teaching practices of science teachers in terms of data collection and analyses when grouped as to sex; however, there is no significant difference when grouped as to age, number of years in teaching science, and frequency with which science was taught. Moreover, there is no significant difference in the teaching practices of science teachers in terms of critique, argumentation, and explanation, modelling, traditional instruction, and prior knowledge across all demographic factors.

As supported by Pranoto, Utami, Latiana, and Ahmadi (2021), this result challenges the common stereotypes associated with older and younger teachers, which can sometimes lead to inaccurate judgments about their

teaching abilities. The focus should be on individual teaching effectiveness rather than assuming that age is a primary predictor of skill.

The result would challenge the common assumptions about age-based differences in teacher effectiveness and potentially reshape social theories about expertise, experience, and knowledge transmission. It might imply that factors other than age, like individual differences, training, or institutional support, play a more significant role in shaping teaching practices. This could also imply that age is not a major factor influencing the adoption of constructivist approaches in teaching. This means that factors other than age, such as training, experience, beliefs, or even personal teaching styles, might be more significant in shaping how teachers implement constructivist principles. It could also suggest that constructivism is increasingly becoming a widely accepted and practiced teaching approach, regardless of age.

This result also suggests that experience alone may not be a strong predictor of effective teaching in science. However, mentorship programs might need to be redesigned to focus on specific teaching skills and knowledge rather than solely relying on the experience of veteran teachers. Even with no significant difference based on experience, the need for continuous professional development and the pursuit of ongoing learning opportunities for all science teachers remains crucial.

The absence of a significant difference in teaching practices across different teaching experience groups does not inherently support constructivist theory. While a lack of difference could suggest a certain level of consistency in teaching approach, it doesn't prove that it's a result of constructivist principles or that constructivism is being effectively implemented. However, it is not sufficient to draw conclusions about the effectiveness of constructivist theory. It only highlights that different teachers, with varying experiences, might be teaching similarly, but not necessarily in a way that aligns with constructivist principles.

This finding supports Arif and Nawaz (2020), who explored the effect of pedagogical beliefs and practices during classroom instruction on students' learning in tehsil Sarai Alamgir, district Gujrat and it was found after analysis that male science teachers tend to engage more than their female counterparts during classroom instruction compared to other teachers.

The result contradicts that of Guansing and Natividad (2024), who mentioned that globally, novice and experienced teachers differ in practices, yet challenges remain consistent regardless of age or experience. Teachers with over ten years of service are particularly well-equipped to reflect on changes in the educational system.

This finding could challenge the core principles of Constructivist Theory. Constructivism suggests that learning is an active process where students construct their own understanding based on their prior knowledge and experiences, and that teaching should be student-centered. If teachers with different teaching frequencies demonstrate similar practices, it could suggest that the teaching style (or lack thereof) is not significantly influencing the student's active construction of knowledge. The focus on student-centered activities and the teacher's role as a facilitator might not be fully implemented or that other factors are more influential in shaping students' learning experiences.

With this, researcher accepts the null hypothesis, as there is no statistically significant difference in the teaching practices of science teachers as a whole and in terms of instigating and investigation, data collection and analyses, critique, argumentation, and explanation, modelling, traditional instruction, and prior knowledge when grouped as to frequency with which science was taught.

Relationships between Pedagogical Beliefs and Teaching Practices of Science Teachers

The data in Table 3 indicate that the correlation between pedagogical beliefs as a whole and teaching practices as a whole stands out significantly, with a strong positive correlation ($r = .532$, $Sig = .002$).

As for the categories of pedagogical beliefs and teaching practices, the correlation between direct transmission beliefs and instigating and investigation ($r = .441$, $Sig = .013$); direct transmission beliefs and modelling ($r = .478$,

Sig = .007); direct transmission beliefs and traditional instruction ($r = .466$, Sig = .009); direct transmission beliefs and prior knowledge ($r = .392$, Sig = .029); and Constructivist Beliefs and Traditional Instruction ($r = .6509$, Sig = .004), appear weaker but still statistically significant.

However, the correlation between Direct Transmission Beliefs and Data Collection and Analyses ($r = .350$, Sig = .054); Direct Transmission Beliefs and Critique, Argumentation, and Explanation ($r = .203$, Sig = .272); Constructivist Beliefs and Instigating and Investigation ($r = .221$, Sig = .231); Constructivist Beliefs and Data Collection and Analyses ($r = .301$, Sig = .100); Constructivist Beliefs and Critique, Argumentation, and Explanation ($r = .265$, Sig = .149); Constructivist Beliefs and Modelling ($r = .180$, Sig = .333) and Constructivist Beliefs and Prior Knowledge ($r = .307$, Sig = .093) is positive but not significant.

Table 3Correlations between the Pedagogical Beliefs and Teaching Practices of Science Teachers

| Variables | r-value | Sig. | |
|---|--------------------|------|--------|
| Direct Transmission Beliefs and Instigating and Investigation | .441* | .013 | Direct |
| Transmission Beliefs and Data Collection and Analyses | .350 ^{ns} | .054 | |
| Direct Transmission Beliefs and Critique, Argumentation, and Explanation | .203 ^{ns} | .272 | |
| Direct Transmission Beliefs and Modelling | .478* | .007 | |
| Direct Transmission Beliefs and Traditional Instruction | .466* | .009 | |
| Direct Transmission Beliefs and Prior Knowledge | .392* | .029 | |
| Constructivist Beliefs and Instigating and Investigation | .221 ^{ns} | .231 | |
| Constructivist Beliefs and Data Collection and Analyses | .301 ^{ns} | .100 | |
| Constructivist Beliefs and Critique, Argumentation, and Explanation | .265 ^{ns} | .149 | |
| Constructivist Beliefs and Modelling | .180 ^{ns} | .333 | |
| Constructivist Beliefs and Traditional Instruction | .6509* | .004 | |
| Constructivist Beliefs and Prior Knowledge | .307 ^{ns} | .093 | |
| Pedagogical Beliefs and Teaching Practices of Science Teachers as a Whole | .532* | .002 | |

* $p < .05$ significant @5% alpha level

Ns $p > .05$ not significant @5% alpha

A strong positive correlation between science teachers' pedagogical beliefs and their teaching practices suggests that teachers' beliefs about how best to teach science are consistently reflected in their classroom actions. This implies that teachers are generally practicing what they believe to be effective.

The result shows that some categories of pedagogical beliefs are not strongly positively correlated with certain categories of teaching practices among science teachers. This suggests that teachers' beliefs alone may not be sufficient to predict or drive their classroom actions. This raises several implications, including the need for more nuanced understanding of teacher practice and the potential for inconsistencies between what teachers believe and how they teach.

This aligns with Arif & Nawaz (2020), who explored the effect of pedagogical beliefs and practices during classroom instruction on students' learning and found that there is strong association between pedagogical beliefs and practices during classroom instruction and students' learning, practices of pedagogical beliefs during classroom instruction. The results reveals that the teachers who had high degree of pedagogical beliefs and practiced perfectly/ great extent pedagogical beliefs theirs students had level of learning and performed "excellent", the teachers who had moderate degree of pedagogical beliefs and practiced some extent pedagogical beliefs theirs students had medium level of learning and performed "good", and the teachers who had low degree of pedagogical beliefs and practiced not at all pedagogical beliefs during classroom instruction, theirs students had low level of learning and majority of them performed "average" in test.

This finds support from study of Yan (2017), who studies]d on the relationship between teachers' beliefs and their instruction. The results showed that teachers' beliefs were positive and significant predictors of their instructional practices.

Arif & Nawaz (2020), who explored the effect of pedagogical beliefs and practices during classroom instruction on students' learning in tehsil Sarai Alamgir, district Gujrat found that there is strong association between pedagogical beliefs and practices during classroom instruction and students' learning, practices of pedagogical beliefs during classroom instruction.

This finding validates the claim of Namoco & Zaharudin (2021) that teacher beliefs about learning and teaching have been found to shape teachers' practices. The assessment of learning practices of the teachers is shaped by their pedagogical beliefs. Also, Tran-Thanh (2021) who found that teachers' pedagogical competence and beliefs affected their pedagogical practices.

This result also aligns with Ligado, Guray, & Bautista (2022), who investigated the pedagogical beliefs, techniques, and practices on effective hands-on science among the teachers in a school's division in the Philippines and they found that respondents' pedagogical beliefs are highly correlated to their pedagogical techniques and moderately correlated with their practices. Beliefs have been found to influence teachers' pedagogical practices and ultimately impact on learning and understanding of concepts. These beliefs can be classified as originating from one's religion or one's culture.

As a support, Dogan, Cakir, Tillotson, Young & Yager (2020) express that teachers' educational beliefs influence their classroom practices which involve their decisions. Their study identifies how the beliefs and classroom practices of high-school science teachers change within the first three years of working. The findings show that teachers cannot practice their reformist beliefs without experiencing real class environments.

However, this result contradicts Luft, Navy, Wong, & Hill (2022), who examined the beliefs and practices of secondary science teachers over a 5-year period. The results highlighted the difficulty in changing the instruction of the teachers, administrative decisions that constrained or contributed to the learning of the new teachers, and the different professional learning opportunities new teachers drew upon over time. These results suggest that early professional development experiences provided some support for the newly hired teachers, but not enough to challenge their beliefs or establish the instructional repertoires envisioned in the science education reforms.

The finding is not congruent with Chen, Hong, Ye, & Ho (2022), who said that the role of teachers' constructivist beliefs in classroom observations based on a social cognitive theory perspective showed that teachers' constructivist belief in teaching was negatively related to psychosocial stress due to social interactions and situations.

A significant positive correlation between teachers' pedagogical beliefs and their teaching practices provides strong evidence for all three theories: the Theory of Reasoned Action, constructivist theory, and social theory. Their positive correlation provides valuable insights into how teachers' beliefs shape their classroom actions and how these actions, in turn, influence student learning.

In view of the foregoing findings, the following conclusions were created: (1) Science teachers hold high levels of both direct transmission and constructivist pedagogical beliefs. This suggests a complex and perhaps mixed approach to teaching, potentially leading to some inconsistencies in science classroom practice. High constructivist beliefs would encourage active student learning, while high direct transmission beliefs might prioritize knowledge transfer and teacher-centered instruction; (2) Grouping all science teachers by sex, age, number of years in teaching science, and frequency with which science was taught reveals that their beliefs about direct transmission and constructivism are high indicates a strong emphasis on direct instruction in classrooms, with teachers likely viewing knowledge as something to be delivered rather than actively constructed by students. Conversely, it could also mean that teachers, despite holding constructivist beliefs, are not fully translating those beliefs into practice, potentially due to various contextual factors; (3) The level of teaching practices of science teachers as whole and in terms of its subcategories is high which suggests a positive impact on student learning outcomes, such as improved understanding of scientific concepts and enhanced engagement in learning. Furthermore, schools may experience a more positive learning environment with greater emphasis on student-centered instruction and collaborative learning; (4) The levels of teaching practices of science teachers in terms of data collection and analyses, critique, argumentation, and explanation, modelling, traditional instruction, and prior knowledge is high

across all demographic factors. This indicates that regardless of their age, sex, number of years in teaching, and frequency with which science was taught, science teachers are consistently implementing high-quality instructional practices, leading to better student outcomes and engagement. Conversely, the moderate level of teaching practices of science teachers in terms of instigating and investigation across all demographic factors means that teachers are not always pushing students to explore, question, and deeply engage with scientific concepts through investigation; (5) The statistically significant difference in direct transmission beliefs of science teachers exists when grouped by age, suggests that older teachers hold stronger direct transmission beliefs, the conclusion might suggest that older teachers' beliefs are more aligned with traditional teaching methods. However, this suggests that sex, number of years in teaching science, and frequency with which science was taught are not be strong determinants of their teaching beliefs; (6) The significant differences in science teaching practices regarding data collection and analysis are found when teachers are grouped by sex, suggests that female teachers show better performance in theory and lab-based classes than male teachers. This also suggests different strengths and preferences in data-driven instruction. The result further shows that no significant difference in teaching practices exists between science teachers grouped by age, number of years in teaching, and frequency with which science was taught which implies that these demographic factors are not strong predictors of how well teachers deliver science instruction; and (7) The significant relationship that exists between science teachers' overall pedagogical beliefs and their overall teaching practices suggests that a teacher's beliefs about how students learn and how science should be taught strongly influence their classroom actions. The result that no significant relationship exists between certain areas of pedagogical beliefs and teaching practices of science teachers suggests that teachers' beliefs about teaching may not be directly and consistently reflected in their classroom actions. This could indicate that other factors play a more influential role in shaping teaching practices.

With the findings above and conclusions, the following were recommended: (1) Science teachers may continue to leverage both approaches to create a more dynamic and effective learning environment. This can be achieved by strategically incorporating elements of direct instruction for foundational knowledge and constructivist methods for deeper understanding and application. They may attend workshops, conferences, and other professional development opportunities to enhance your knowledge and skills in both direct transmission and constructivist teaching methods; (2) The school community may create a supportive environment where science teachers can thrive and continue to develop their skills and knowledge, ultimately leading to improved student learning and achievement. This could involve providing opportunities for collaboration, mentoring, and professional development aligned with their specific interests and areas for improvement. Additionally, promoting a school culture that values and supports effective teaching practices is crucial; (3) The science teachers, including administrators and support staff, may provide more significant support in maintaining excellence and exploring innovative approaches. These include continuing to develop student-centered learning environments, fostering a culture of collaboration and mentorship, and staying abreast of current research and emerging technologies in science education. Science teachers may also focus on enhancing instigation and investigation skills through targeted professional development, collaborative planning, and resource utilization, all with the goal of shifting towards a more inquiry-based teaching approach; (4) If the levels of teaching practices of science teachers are high across all age, sex, number of years in teaching, and frequency with which science was taught, science teachers may shift from addressing disparities to sustaining and enhancing these high levels of practice. This includes reinforcing existing best practices, promoting continued professional development, and ensuring a supportive school environment; (5) The significant difference in direct transmission beliefs is found among science teachers based on age, suggests understanding the reasons behind the age-related differences, implementing professional development tailored to address those differences, and exploring ways to encourage teachers to adopt a more constructivist or learner-centered approach to science education. By addressing the significant difference in direct transmission beliefs through targeted professional development, promoting a more constructivist approach, and addressing potential challenges, schools can create a learning environment that is more effective and equitable for all students; (6) Significant gender differences are found in how male and female science teachers practice data collection and analysis and this suggests that the school community may focus on promoting equitable practices, addressing potential biases, and providing professional development opportunities. This includes ensuring all teachers have access to quality resources, mentorship, and training on best practices in data-driven instruction and equitable assessment; (7) A strong relationship that exists between science teachers' pedagogical beliefs and their teaching practices suggests that the school community, including the administration may focus on fostering alignment between these two aspects. This includes providing professional development that explicitly addresses

the connection between beliefs and practices, encouraging reflective teaching practices, and supporting teachers in aligning their beliefs with their instructional choices. Workshops and training sessions may demonstrate how to implement teaching practices that align with specific pedagogical beliefs; (8) Students benefit from understanding the connection between a science teacher's beliefs about teaching and their actual teaching methods to better engage with their learning. Teachers with strong pedagogical beliefs, aligned with their practices, are more likely to create effective learning experiences; and (9) Future research may focus on the specific ways pedagogical beliefs translate into classroom actions. This includes exploring how teachers' beliefs about student learning, teaching methods, and the nature of science influence their lesson planning, classroom management, and student assessment strategies.

References

1. Al-Baqmi, 2019. *The practice of science teachers in the second stage in Light teachers' standards and career paths*. Faculty of Education, Assiut University, 7 (35) (2019), pp. 485-500. <https://doi.org/10.1016/j.ssaho.2021.100236>
2. Almunawaroh, N. F., Diem, C. D. and Steklács, J. (2024). *EFL teachers' pedagogical beliefs, pedagogical content knowledge, and instructional material use: a scale development and validation*. *Cogent Education*, 11(1), pg 1–16. DOI: <https://doi.org/10.1080/2331186X.2024.2379696>
3. Ambusaidi, A. K. and Al-Maqbali, F. Y. (2022). Exploring pedagogical decision making from the lens of science teachers in response to different pedagogical issues. *Social Sciences & Humanities Open*, 5 (1). <https://doi.org/10.1016/j.ssaho.2021.100236>.
4. Anoling, KM., Abella, CRG., Cagatao, PPS., and Bautista, RG. (2024). Critical Perspectives, Theoretical Foundations, Practical Teaching, Technology Integration, Assessment and Feedback, and Hands-on Practices in Science Education. *American Journal of Educational Research*, 12 (1), pp. 20-27.
5. Arif, M. and Nawaz, M. H. (2020). Exploring the Effect of Pedagogical Beliefs and Practices during Classroom Instruction on Students Learning at Secondary School Level in District Gujrat. *Ilkogretim Online - Elementary Education Online*, 19 (3) pp. 2480-2487 <http://ilkogretim-online.org> doi: 10.17051/ilkonline.2020.03.735406
6. Bandura, A. (1997). *Self-efficacy: The exercise of control*. W.H Freeman and Company.
7. Baniqued, W. B. and Bautista, R. G. (2024). Teachers' Preparedness on Pedagogical Practices in K-12 Science Education: Foundations for Crafting an Effective Science Program. *American Journal of Educational Research*. 2024; 12(8), pp. pp. 291-297. Doi: 10.12691/education-12-8-1
8. Barni, D., Danioni, F., & Benevene, P. (2019). Teachers' self -efficacy: The role of personal values and motivations for teaching. *Frontiers in Psychology*, Vol. 10, pp. 1–7. <https://doi.org/10.3389/fpsyg.2019.01645>
9. Beane, J.A. (1997). *Curriculum Integration: Designing the Core of Democratic Education*. Teachers College Press: New York, NY, USA
10. Berber N. Langelaan, Lisa Gaikhorst, Wouter Smets, Ron J. Oostdam (2024). Differentiating instruction: Understanding the key elements for successful teacher preparation and development. *Teaching and Teacher Education*, Volume 140. <https://doi.org/10.1016/j.tate.2023.104464>.
11. Berisha, F., & Vula, E. (2021). *Developing Pre-service Teachers Conceptualization of STEM and STEM Pedagogical Practices*. *Frontiers in Education*. <https://doi.org/10.3389/educ.2021.585075>
12. Bernardo, J. (2020). *PH ranks last among 58 countries in grade 4 math, science*: Study. ABS-CBN News. <https://news.abs-cbn.com/amp/news/12/09/20/ph-ranks-last-among-58-countries-in-grade-4-math-science-study>
13. Bibi, A., Yamin, S., Natividad, L. R., Rafique, T., Akhter, N., Fernandez, S. F., & Samad, A. (2024). Navigating the ethical landscape: AI integration in education. *Educational Administration: Theory and Practice*, 30(6), pp. 1579- 1585. <https://doi.org/10.53555/kuey.v30i6.5546>
14. Bibon, M. B. (2022). Teachers' Instructional Practices and Learners' Academic Achievement in Science. *Contemporary Mathematics and Science Education*, 3(1), ep22007. <https://doi.org/10.30935/conmaths/11816>
15. Blazar, D. (2016). *Teacher and teaching effects on learners' academic performance, attitudes, and behaviors*. Doctoral dissertation, Harvard Graduate School of Education. <https://dash.harvard.edu/handle/1/27112692>
16. Borines, M. T. E. L. and Marasigan, A. C. (2022). Theorizing Filipino Pedagogical Beliefs: Narratives of Preservice Elementary Teachers' Before and After Teaching Immersion. *British Journal of Teacher Education and Pedagogy*, 3(1): pp. 45-57. DOI: 10.32996/bjtep

17. Cadiz, M. C. D., Manuel, L. A. F., Reyes, M. M., Natividad, L. R., & Ibarra, F. P. (2024). Technology integration in Philippine higher education: A content-based bibliometric analysis. *Jurnal Ilmiah Ilmu Terapan Universitas Jambi*, 8(1), 35-47. <https://doi.org/10.22437/jiituj.v8i1.31807>
18. Canonizado, I. C. (2024). *When to Use Total Population Sampling in a Research Study*. HubPages. <https://discover.hubpages.com/education/When-to-use-total-population-sampling-in-a-research-study>
19. Cantwell, P. (2008). *Census*. In Encyclopedia of survey research methods Vol. 0, pp. 91-93. Sage Publications, Inc., <https://doi.org/10.4135/9781412963947.n61>
20. Capablanca, M. (2023). Practices Affecting the Science Teachers' Teaching Performance in Public Junior High Schools. *Psychology and Education: A Multidisciplinary Journal*, 14(9), 1132-1146. <http://dx.doi.org/10.5281/zenodo.10068858>
21. C, eliker-Ercan, G., & C, ubukc, u, Z. (2023). Curriculum implementation approaches of secondary school English teachers: A case study. *Kastamonu Eğitim Dergisi*, 31(3), 347–366. <https://doi.org/10.24106/KEFDERGI-2021-0006>
22. Chan, Joefrey R. et al. (2020). Constructivism and Pedagogical Practices of Science Teachers. *IOER International Multidisciplinary Research Journal*, 2 (2). <https://ssrn.com/abstract=3601705>
23. Chen P-H, Hong J-C, Ye J-H & Ho Y-J (2022) *The Role of Teachers' Constructivist Beliefs in Classroom Observations: A Social Cognitive Theory Perspective*. *Front. Psychol.* 13:904181. doi: 10.3389/fpsyg.2022.904181
24. Cheng, L., Antonenko, P.D. & Ritzhaupt, A.D. (2024). The Impact of Teachers' Pedagogical Beliefs, Self-Efficacy, and Technology Value Beliefs on 3D Printing Integration In K-12 Science Classrooms. *Education Tech Research Dev* 72, 181–208. <https://doi.org/10.1007/s11423-023-10276-3>
25. Cherry, F. E., (2019). *Stubborn Particulars of Social Psychology: Essays on the Research Process*. Routledge
26. Ciske, N., Mantlana, D. and Nyembezi, N. (2015). Teaching Practices from a Theoretical Perspective 2015 *Int J Edu Sci*, 9(2): 163-171. file:///C:/Users/user/Downloads/IJES92163-5212015.pdf
27. Cohen, L., Manion, L., & Morrison, K. (2007). *Research Methods in Education (6th ed.)*. Routledge. <https://doi.org/10.4324/9780203029053>
28. Creswell, J. W. (2012). Educational research: Planning, conducting, and evaluating quantitative and qualitative research (4th ed.). Boston, MA: Pearson.
29. Czerniak, C.M.; Johnson, C.C. Interdisciplinary Science Teaching. In *Handbook of research on Science Education*; Abell, S.K., Lederman, N.G., Eds.; Routledge: New York, NY, USA, 2014; pp. 395–411.
30. Dasas, L.B. (2020). Filipino teachers' reflections on critical pedagogy (CP) in science education. *The Normal Lights*, 14(2), 221 – 247. file:///C:/Users/user/Downloads/Administrator,+TNL_14_2_Dasas.pdf
31. DeCoito, I., & Myszkal, P. (2018). Connecting Science Instruction and Teachers' SelfEfficacy and Beliefs in STEM Education. *Journal of Science Teacher Education*, 29(6), 485–503. <https://doi.org/10.1080/1046560X.2018.1473748>
32. Dewey, J. (1938). *Experience and Education*. New York: Macmillan Company
33. Dogan , O. K., Cakir, M., Tillotson, J. W., Young , M. & Yager, R. E. (2020). A Longitudinal Study of a New Science Teacher's Beliefs and Classroom Practices. *International Journal of Progressive Education*, 16 (1). https://ijpe.inased.org/files/2/manuscript/manuscript_1253/ijpe-1253-manuscript-212555.pdf
34. Dunlop, L.; Turkenburg-van Diepen, M.; Knox, K.J.; & Bennett, J. Open-ended investigations in high school science: Teacher learning intentions, approaches and perspectives. *Int. J. Sci. Educ.* 2020, 42, 1715–1738.
35. Elmas, R., B. Demirdöğen, & Ö. Geban. 2011. "Preservice Chemistry Teachers' Images about Science Teaching in Their Future Classrooms." *Hacettepe University Journal of Education* 40: 164–175.
36. Fishbein, M., & Ajzen, I. (1975). *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Addison-Wesley. <https://doi.org/10.1017/CBO9781107415324.004>
37. Fishbein, Martin. (2008). *Theory of Reasoned Action*. In Wolfgang Donsbach (Ed.). The International Encyclopedia of Communication (First edit). John Wiley & Sons, Ltd. <https://doi.org/10.1002/9781405186407.wbiecr017>
38. Gabunilas, L. M. and Obiedo, R. V. (2024). Exploring the Science Teaching and Technology Beliefs of Pre-Service Science Teachers in a Philippine State University. *Annual Report of Asia & ASEAN Center for Educational Research*, 4 (1). Pp. 97-98. https://www.academia.edu/117050402/Exploring_the_Science_Teaching_and_Technology_Beliefs_of_Pre_Service_Science_Teachers_in_a_Philippine_State_University

39. Gao, Y., & Cui, Y. (2024). English as a foreign language teachers' pedagogical beliefs about teacher roles and their agentic actions amid and after COVID-19: A case study. *RELC Journal*, 55(1), 111–127. <https://doi.org/10.1177/00336882221074110>
40. Gilleece, L. (2012). Teachers' Pedagogical Beliefs: Findings from the First OECD Teaching and Learning International Survey. In Johannes König (Ed.), *Teachers' Pedagogical Beliefs: Definition and Operationalisation – Connections to Knowledge and Performance – Development and Change*, (pp 110-130).
41. Guansing, J. P., & Natividad, L. R. (2024). A decade to remember: Attitudes, practices, and challenges of junior high school science teachers. *Education Digest*, 19(2), 69-81.
42. Guerreo, JS., & Bautista, RG. (2023). Inquiry-based teaching in secondary science. *International Journal of Social Sciences and Humanities*, 8(2), 146-154.
43. Haatainen, O., Turkka, J., & Aksela, M. (2021). Science Teachers' Perceptions and Self-Efficacy Beliefs Related to Integrated Science Education. *Education Sciences*, 11(6), 272. <https://doi.org/10.3390/educsci11060272>
44. Habte, A., Bishaw, A., & Lechissa, M. (2021). Beyond policy narratives: Exploring the role of pedagogical beliefs in classroom practices of secondary school Civics and Ethical Education teachers. *Smart Learning Environments*, 8(26), pp. 1–26. <https://doi.org/10.1186/s40561-021-00171-w>
45. Hansson, L., Hansson, Ö., Juter, K., & Redfors, A. (2021). Curriculum emphases, mathematics and teaching practices: Swedish upper-secondary physics teachers' views. *International Journal of Science and Mathematics Education*, 19(3), pp. 499-515. <https://doi.org/10.1007/s10763-020-10078-6>
46. Hayes, K. N. and Allen, C. D. (2025). Understanding Science Teacher Learning as Situated in Organizational Contexts: Introduction to the Special Issue. *Science Education*, 10.1002/sci.21960.
47. Hayes, K.N. Lee, C. S., DiStefano, R., O'Connor, D., & Seitz, J. (2016). Measuring science instructional practice: A survey tool for the age of NGSS. *Journal of Science Teacher Education*. 27, 137-164.
48. Johnson, A. (2017). The relationship between teacher practice and learner performance. *Seton Hall University Dissertation and Theses*. <https://scholarship.shu.edu/dissertation/2235>
49. Johnson, B. & Christensen, L. (2014). *Educational Research: Quantitative, Qualitative, and Mixed Approaches*. 5th Edition, SAGE Publications, London.
50. Kaluyu, V. (2020). Pedagogy and Information Technology Integration, As Strategies for Improving Academic Performance in Stem Subjects: A Critical Literature Review. *Journal of Education and Practice*, 11(21), 184–202. <https://doi.org/10.7176/jep/11-21-21>
51. Kanlı, U., & Ilican, Ö. (2020). Student Achievement on the Concepts of Light and Shadow in Different Assessment Formats: Students' Learning Styles and Gender. *Journal of Turkish Science Education*, 17(4), 468–486. <https://doi.org/10.36681/tused.2020.39>
52. Kirkiç, K. A and Yahşi, O. (2021). The Characteristics of Innovative Teachers: The Relationship between Science Teachers' Views on Student Achievement and Learning and Teaching Motivation. *Science Education International* 32(1), 63-71. <https://doi.org/10.33828/sci.v32.i1.7>
53. Kolb, D.A., (2015). *Experiential learning Second Edition*. <https://ptgmedia.pearsoncmg.com/images/9780133892406/samplepages/9780133892406.pdf>.
54. Kolovou, M. (2022). Lessons from the past: Reviewing how we teach science, what's changed, and why it matters. *Science & Education*, Vol. 31, pp. 855-859, 10.1007/s11191-021-00267-2
55. König, J. (2012). *Teachers' Pedagogical Beliefs: Definition and Operationalization - Connections to Knowledge and Performance Development and Change*. <https://www.waxmann.com/index.php?eID=download&buchnr=2696>
56. Kwak, Y. (2019). Secondary school science teacher education and quality control in Korea based on the teacher qualifications and the teacher employment test in Korea. *Asia-Pacific Science Education*, 5(1), 14. <https://doi.org/10.1186/s41029-019-0040-0>
57. Leuchter, M.; Saalbach, H.; Studhalter, U.; Tettenborn, A. Teaching for conceptual change in preschool science: Relations among teachers' professional beliefs, knowledge, and instructional practice. *Int. J. Sci. Educ.* 2020, 42, 1941–1967.
58. Ligado, FN. G., Guray, N. D., & Bautista, R. G. (2022). Pedagogical Beliefs, Techniques, and Practices towards Hands-on Science. *American Journal of Educational Research*, 2022, Vol. 10 (10), pg. 584-591. DOI:10.12691/education-10-10-1
59. Lin, X., Hmelo-Silver, C. E., & Lan, Y.-J. (2019). Using Inquiry-Based Learning to Enhance Students' Critical Thinking Skills in Science. *Journal of Research in Science Teaching*, 49(5), 566-589.

60. Lorincz, M. (2023). EFL student teachers' beliefs about language teaching approaches and instructional practices. *Electronic Journal of Foreign Language Teaching*, 20(2), 167–192. <https://e-flt.nus.edu.sg/v20n22023/lorincz.pdf><https://doi.org/10.56040/mlrc2024>
- 61.
62. Luft, J. A., Navy, S. L., Wong, S. S. and Hill, K. M. (2022). The first 5 years of teaching science: The beliefs, knowledge, practices, and opportunities to learn of secondary science teachers. *J Res Sci Teach*, 59:1692–1725. <https://doi.org/10.1002/tea.21771>
63. Namoco, S. and Zaharudin, R. (2021). Pedagogical Beliefs and Learning Assessment in Science: Teacher's Experiences Anchored on Theory of Reasoned Action. *Journal of Turkish Science Education*, 18(2), pp. 304-319. DOI no: 10.36681/tused.2021.67
64. McLure, F, Won, M. and Treagust, D. F. (2024). Science teachers' understanding of creative thinking and how to foster it as mandated by the Australian Curriculum. *Journal of Science Teacher Education*. 10.1080/1046560X.2024.2313882
65. Macugay, Eva B. The Relationship Between Cultural and Pedagogical Beliefs of Science Teachers in Ilocos Norte: Its Implications for Science Teacher Education. *MMSU CTE Research Journal*, 2 (1).
66. Majo, S. (2016). *Factors influencing poor performance in science subjects in secondary schools in Shinyanga Municipality, Munich*. GRIN Verlag. <https://www.grin.com/document/383487>
67. Margot, K.C.; Kettler, T. (2019). Teachers' perception of STEM integration and education: A systematic literature review. *Int. J. Stem Educ.*, Vol. 6, 1–16.
68. Masuhara, H. (2022). *Approaches to materials adaptation*. In J. Norton & H. Buchanan (Eds.). *The Routledge handbook of materials development for language teaching* (pp. 277–289). Routledge. <https://doi.org/10.4324/b22783-24>
69. Mönch, C., & Markic, S. (2022). Science Teachers' Pedagogical Scientific Language Knowledge—A Systematic Review. *Education Sciences*, 12(7), 497. <https://doi.org/10.3390/educsci12070497>
70. Namoco, S. & Zaharudin, R. (2021). Pedagogical Beliefs and Learning Assessment in Science: Teacher's Experiences Anchored on Theory of Reasoned Action. *Journal of Turkish Science Education*, 2021, 18(2), 304-319. DOI no: 10.36681/tused.2021.67
71. Nozoe, S., & Isozaki, T. (2020). What affects Japanese science teachers' pedagogical perspectives in lower secondary schools? A case study of international comparison between Hiroshima (Japan) and Leeds (England). *International Journal of Science Education*, 42(13), 2246–2265. <https://doi.org/10.1080/09500693.2020.1817608>
72. O'Connor, W. V. & Natividad, L. R. (2023). The bias on artificial intelligence in education (AIED): Influence of perennialism teaching philosophy at Education 4.0. *Journal of Science and Technology Educators*, 5(1), 31- 44.
73. Ogegbo, A. A., Gaigher, E., & Salagaram, T. (2019). Benefits and challenges of lesson study: A case of teaching Physical Sciences in South Africa. *South African Journal of Education*, 39(1). <https://doi.org/10.15700/saje.v39n1a1680>
74. Organization for Economic Co-operation and Development (OECD). *PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematics, Financial Literacy and Collaborative Problem Solving*; PISA: Paris, France; OECD: Paris, France, 2017.
75. Pei, X. & Zheng, T. (2021). Comparative study on development of science education worldwide: Advance in ideas, themes, and practice. *Bulletin of Chinese Academy of Sciences*, 36 (7), pp. 771-778, 10.16418/j.issn.1000-3045.20210517001
76. Pranoto, Y. K. S., Utami, D. R. F., Latiana, L. & Ahmadi, F. (2021). Do Teachers' Experiences and Ages Contribute to Their Teaching Performance? *Proceedings of the 11th Annual International Conference on Industrial Engineering and Operations Management Singapore*, March 7-11, 2021. <http://www.ieomsociety.org/singapore2021/papers/629.pdf>
77. Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L., & Koole, M. (2021). Balancing technology, pedagogy and the new normal: Post-pandemic challenges for higher education. *Postdigital Science and Education*, 3(3), 715-742. <https://doi.org/10.1007/s42438-021-00249-1>
78. Reese, H. W. (2011). *The learning-by-doing principle*. *Behavioral Development Bulletin*, 17(1), 1-19.
79. Rosel, L. L., Valdez, R. A., Bautista, A. S., & Dimaano, N. S. (2019). Assessment practices in science education: An exploration in Philippine schools. *Journal of Physics: Conference Series*, 1407(1), 012006.

80. Rudolph, J. L. (2024). Scientific literacy: Its real origin story and functional role in American education. *Journal of Research in Science Teaching*, 61 (3), pp. 517-735. 10.1002/tea.21890
81. Sari, U., Duygu, E., Şen, Ö. F., & Kirindi, T. (2020). The effects of STEM education on scientific process skills and STEM awareness in simulation based inquiry learning environment. *Journal of Turkish Science Education*, 17(3), pp. 387–405. <https://doi.org/10.36681/tused.2020.34>
82. Schutz, P. A., Hong, J. Y., & Francis, D. C. (2020). *Teachers' goals, beliefs, emotions, and identity development: Investigating complexities in the profession (1st ed.)*. Routledge. <https://doi.org/10.4324/9780429456008>
83. Shamim , M. R. H., Mamun , M. A. A., & Raihan , M. A. (2022). Mapping the Research of Technical Teachers' Pedagogical Beliefs about Science Technology Engineering and Mathematics (STEM) Education. *International Journal of Instruction*, 15(4), 797–818. Retrieved from <https://e-iji.net/ats/index.php/pub/article/view/288>
84. Shaikat, S., Vishnumolakala, V. R. , & Hamdan Alghamdi , A. K. (2020). Science Teachers' Perceptions of Personal Science Efficacy Beliefs and Science Teaching in Saudi Arabia, Pakistan, and the United Arab Emirates. *EURASIA Journal of Mathematics, Science and Technology Education*, 16(8). <https://doi.org/10.29333/ejmste/8290>
85. Tan, X., & Matsuda, P. K. (2020). *Teacher beliefs and pedagogical practices of integrating multimodality into first-year composition*. *Computers and Composition*, 58, 102614. <https://doi.org/10.1016/j.compcom.2020.102614>
86. Tan, Y.S.M., Caleon, I.S. (2023). *The Influence of Science Teachers' Beliefs and Practices on Students' Learning Spaces and Processes: Insights from Singapore*. In: Maulana, R., Helms-Lorenz, M., Klassen, R.M. (eds) *Effective Teaching Around the World* . Springer, Cham. https://doi.org/10.1007/978-3-031-31678-4_28
87. Tran-Thanh, V. (2021). Why I don't teach as I was trained": Vietnamese early career ESOL teachers' experience of reality shock. *Australian Journal of Teacher Education*, 46(12), 35–51. <https://doi.org/10.14221/ajte.2021v46n12.3>
88. Villavicencio, A. D., Licup, J. H., Magat, L. G. & David, A. G. (2022). Senior High School Teachers' Attitude and Pedagogical Practices towards Statistics and Probability. *Asia Pacific Journal Education Perspective Vol. 9 No. 1, pp. 26-35*. <https://research.lpubatangas.edu.ph/wp-content/uploads/2022/09/4-APJEP-2022-39-Villavicencio-et-a-l.pdf>
89. Wilfredo B. Baniqued and Romiro G. Bautista. Teachers' Preparedness on Pedagogical Practices in K-12 Science Education: Foundations for Crafting an Effective Science Program. *American Journal of Educational Research*, 12(8):291-297. DOI: 10.12691/education-12-8-1
90. Willemsen et al. (2023). The role of creative thinking in children's scientific reasoning. *Thinking Skills and Creativity*, Vol. 49. 10.1016/j.tsc.2023.101375
91. Yan, Z. (2017). How teachers' beliefs and demographic variables impact on self-regulated learning instruction. *Educational Studies*, 2017 <https://doi.org/10.1080/03055698.2017.1382331>
92. Yesilyurt, E. (2022). Investigating Elementary Preservice Teachers' Beliefs about Teaching and Learning Science. *National Science teaching Association Journal of College Science Teaching*, 51 (5). <https://www.nsta.org/journal-college-science-teaching/journal-college-science-teaching-mayjune-2022/investigating>
93. Yoshida, M and Sølberg, J. (2024). Science Teachers' Beliefs on Science Teaching and Learning for Implementing in STEM Education. *Science Education International* 35(3), 192-197 <https://doi.org/10.33828/sei.v35.i3.2>
94. Zajić et al. (2021). The role of action research in teachers' professional development. *International Journal of Cognitive Research in Science, Engineering and Education (IJCRSEE)*, 9 (3), pp. 301-317. 10.23947/2334-8496-2021-9-3-301-317