

Critical Perspectives, Theoretical Foundations, Practical Teaching, Technology Integration, Assessment and Feedback, and Hands-on Practices in Science Education

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Abstract Hands-on practices in science education are underscored in a constructivist lens, advocating for experiential learning and direct engagement with scientific concepts. This study aimed to determine the critical perspectives, theoretical foundations, practical teaching, technology integration, assessment and feedback, and hands-on practices in science education as evaluated by the science teachers in the basic and higher education. The Descriptive-Comparative Research design was employed since the study aimed at assessing the thesis as it occurs in its locale without manipulating any variable. The findings revealed a widespread consensus among respondents across various aspects of science education, suggesting promising opportunities for employment and seamless integration throughout different educational tiers. Both males and females generally aligned on critical perspectives, practical teaching methods, and technology integration. However, divergence surfaced in theoretical foundations, assessment, and hands-on practices, showcasing a proficiency gap where female teachers excel. While overall agreement existed among teachers regarding critical aspects of science education, disparities in practical teaching methods persisted among elementary, secondary, and tertiary educators. Respondents from various educational levels showcased uniformity, yet those holding Bachelor's degrees tended to express lower agreement compared to their counterparts with Master's or doctoral degrees. Notably, distinctive views emerged in technology utilization and practical teaching experiences in science education, particularly among Special Science Teachers and Teacher holders when contrasted with Master Teachers, Head Teachers, and Teacher-Educators. These differences emphasized the need for collaborative efforts to bridge gaps and enhance teaching methodologies in science education.

Keywords: *assessment, educational technology, hands-on science, science education*

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1. Introduction

In the relentless pursuit of advancing the landscape of science education, this research is deeply rooted in the principles of constructivism, thereby embarking on a systematic investigation posed to enhance its multifaceted dimensions. The exploration is intricately organized around critical perspectives, theoretical foundations, practical teaching methodologies, technology integration, assessment strategies, and the seamless incorporation of hands-on practices, guided by the overarching objective to not only refine but significantly amplify the effectiveness and pedagogical impact of science education [1,2,3,4]. Through this, the researchers aspire to make a substantive

and enduring contribution to the broader discourse on educational advancement particularly in science education.

At the forefront of the constructivist inquiry are critical perspectives that constitute a primary focus involving a thorough analysis of existing paradigms within science education. This entails not only scrutinizing these paradigms but also discerning potential biases, promoting inclusivity, and contextualizing cultural dimensions in knowledge dissemination. Rooted in the constructivist philosophy, it is the aspiration of the researchers to cultivate an environment that transcends superficial understanding, reflecting a nuanced and inclusive comprehension of diverse perspectives. This foundational step serves as a potent catalyst, fostering equity, and cultural sensitivity within the science education milieu.

The exploration of theoretical foundations represents a

constructivist lens applied to a comprehensive study delving into the underlying principles governing science education. Drawing insights from well-established educational theories, cognitive science principles, and pedagogical models within the constructivist framework, is to understand but to refine the theoretical framework supporting effective science instruction. This scholarly engagement seeks to elevate instructional strategies that aligns them seamlessly with the dynamic contours of contemporary educational paradigms and the learner's active construction of knowledge.

Turning our attention to practical teaching methods, the constructivist approach delves into methodologies strategically designed not only to engage students but to actively involve them in the construction of their understanding of scientific concepts. This investigation extends beyond conventional boundaries, encompassing innovative instructional approaches, emphasizing inquiry-based learning, and integrating real-world applications. Rooted in constructivism, this dedicated segment aims to cultivate a dynamic and interactive learning environment, thereby ensuring the accessibility and relevance of science education that aligns seamlessly with the current pedagogical demands. This allows students to actively build their knowledge.

Furthermore, this research strategically places emphasis on the judicious integration of technology into the science education landscape, which is guided by the constructivist philosophy. Leveraging virtual laboratories, simulation tools, online resources, and educational applications, it is aimed to complement practices and procedures that actively engage learners in the construction of knowledge: aligning science education not only with contemporary technological advancements but also meeting the evolving needs of 21st century learners within a constructivist framework [1,2].

Corollary to these constructivist efforts is the scrutiny of assessment strategies that transcend conventional testing paradigms. Embracing formative assessments, project-based evaluations, and diverse evaluation techniques, this research also aspires, within a constructivist context, to provide not just an evaluative measure but a comprehensive insight into students' active construction of scientific concepts. The adoption of a multifaceted assessment approach aligns seamlessly with the constructivist understanding of evaluation in educational settings, emphasizing the learner's active role in knowledge construction [5].

Moreover, the pivotal role of hands-on practices in science education is underscored through a dedicated constructivist lens, advocating for experiential learning and direct engagement with scientific concepts. This component aims not only to cultivate a profound understanding but also to foster a positive attitude towards science through the promotion of hands-on practices, aligning with the constructivist emphasis on active, experiential learning [6,7]. Serving as a dynamic conduit, this aspect bridges the theoretical-practical dichotomy within the constructivist framework, facilitating tangible and enduring learning experiences for students as they actively construct their knowledge.

The crux is: this research unfolds as a meticulous and

systematic exploration, guided by the constructivist philosophy, not just of critical perspectives, theoretical foundations, practical teaching methods, technology integration, assessment strategies, and hands-on practices within science education. Each carefully examined milestone is not merely a contribution but a substantive step towards the overarching constructivist objective of refining science education practices and aligning them seamlessly with contemporary educational imperatives. This scholarly endeavor, firmly grounded at the intersection of innovation and tradition within a constructivist framework, is set to enrich the broader discourse on educational advancement and pedagogical efficacy within the realms of science education.

2. Methodology

This descriptive research entails a comprehensive exploration aimed at enhancing science education across all levels. The investigation spans Critical Perspectives, Theoretical Foundations, Practical Teaching, Technology Integration, Assessment, and Hands-on Practices. The researchers meticulously crafted a questionnaire that served as the primary data collection tool, targeting science teachers in elementary, secondary, and tertiary education. The instrument's reliability (.977), indicated by a robust alpha coefficient, ensures the credibility of the gathered information.

The study's respondents comprised of science teachers in elementary, secondary, and tertiary levels, specifically those holding positions as Master Teachers, Head Teachers, Special Science Teachers, and Teacher-educators in the college. This selection criteria, including individuals who are actively engaged in science education leadership roles, enhanced the study's depth and ensured a saturated exploration of the thesis. The profile of the respondents is shown in [Table 1](#).

Table 1. Profile of the Respondents

	Profile	Frequency	Percent
Sex	Male	72	37
	Female	122	63
Academic Title	Special Science Teacher	105	54
	Master Teacher	23	12
	Head Teacher	6	3
	Teacher-Educator	60	31
Subject Level Taught	Elementary Science	71	37
	Secondary Science	63	32
	Tertiary Science	60	31
Education	BS	109	56
	MA/MS/MAT	74	38
	PhD	11	6

The data collected underwent analysis using both descriptive and inferential statistical methods. This analysis is conducted with a specific focus on aligning the research parameters with the constructivist principles in science education. The utilization of these statistical techniques added a layer of depth to the study, providing nuanced insights into the multifaceted dimensions of science education.

3. Results and Discussion

1. Critical Perspectives, Theoretical Foundations, Practical Teaching, Technology Integration, Assessment, and Hands-on Practices in Science Education.

Table 2. Critical Perspectives in Science Education

Critical Perspectives in Science Education		Mean	Description
1	Critical thinking skills are integrated into the science curriculum.	3.53	Strongly agree
2	Discussions on the societal and ethical implications of scientific discoveries are included in the curriculum.	3.48	Strongly agree
3	Questioning that establishes scientific knowledge and assumptions is emphasized.	3.49	Strongly agree
4	Students are encouraged to analyze and critique scientific information.	3.62	Strongly agree
5	Open-minded and skeptical approach to scientific claims is promoted in the class	3.51	Strongly agree
6	Students are involved in debates on controversial scientific issues.	3.37	Strongly agree
7	Interdisciplinary perspectives in science education are encouraged.	3.52	Strongly agree
8	The influence of culture on science is promoted and encouraged.	3.60	Strongly agree
9	The history and philosophy of science are explored in the curriculum.	3.52	Strongly agree
10	Students are engaged in ethical decision-making related to science.	3.56	Strongly agree
Grand Mean		3.52	Strongly agree

Table 3. Theoretical Perspectives in Science Education

Theoretical Perspectives in Science Education		Mean	Description
1	There is clarity of theoretical concepts in the science curriculum.	3.49	Strongly agree
2	Educational theories are integrated to enhance science teaching.	3.56	Strongly agree
3	The relevance of educational theories to science education is promoted.	3.56	Strongly agree
4	Different teaching and learning models in science education are explored.	3.58	Strongly agree
5	Constructivist learning theories are incorporated to classroom instruction.	3.39	Strongly agree
6	Cognitive psychology principles to science teaching are applied.	3.48	Strongly agree
7	Pedagogical content knowledge in science instruction is encouraged.	3.53	Strongly agree
8	Students' preconceptions and misconceptions are considered.	3.47	Strongly agree
9	The curriculum is aligned with learning theories.	3.47	Strongly agree
10	Inquiry-based learning in science education is promoted.	3.59	Strongly agree
Grand Mean		3.51	Strongly agree

Table 2 presents the critical perspectives of the respondents in science education. The grand mean of 3.52 and interpreted as *strongly agree* denotes that the respondents hold a strong perspective towards science education vis-à-vis constructivist benchmarks. The vouched responses for item 4, *Students are encouraged to analyze and critique scientific information*, and item 8, *The influence of culture on science is promoted and encouraged*, suggest that the promotion of critical thinking, questioning, and evaluation of evidences on how

scientific advancements are influenced by diverse cultural perspectives, traditions, and histories [8,9]. This further denotes rich and varied voices that contribute to scientific knowledge and research. It also recognizes the fact that cultural contexts are shaped by scientific approaches and innovations.

Table 3 presents the theoretical perspectives of the respondents in science education. The grand mean of 3.51 (*strongly agree*) suggests that teachers depend on a sound theoretical foundation along their activities and procedures in the classroom. The standpoints of the respondents in item 10, *Inquiry-based learning in science education is promoted*, and item 4, *Different teaching and learning models in science education are explored*, denote that a profound understanding of scientific concepts that foster sense of discovery and ownership is promoted. This enhances student engagement and retention of scientific concepts. These varied methods offer diverse methods of instruction in addressing different learning styles and objectives [10,11,12]. Furthermore, these theory-based models emphasize active participation, knowledge application, and interaction to deepen students' understanding of scientific principles [13].

Table 4. Practical Teaching Experiences in Science Education

Practical Teaching Experiences in Science Education		Mean	Description
1	Hands-on laboratory experiences are provided to students.	3.57	Strongly agree
2	Real-world applications in science teaching are evident.	3.62	Strongly agree
3	There are opportunities to practice actual science exploration and experiments.	3.64	Strongly agree
4	Case studies and problem-solving exercises are employed.	3.53	Strongly agree
5	Field trips and outdoor education are conducted.	3.41	Strongly agree
6	Students are always engaged to practical tests and activities.	3.54	Strongly agree
7	Resources and materials for hands-on activities are available.	3.56	Strongly agree
8	Student collaboration and teamwork are encouraged.	3.64	Strongly agree
9	Feedbacks to students' activities are provided.	3.61	Strongly agree
10	The relevance of teaching methods to future career opportunities is always considered.	3.61	Strongly agree
Grand Mean		3.53	Strongly agree

Table 4 presents the practical teaching experiences of the respondents in science education. The grand mean of 3.53 (*strongly agree*) suggests that teachers employ practical, yet adaptive teaching mechanism along their activities and procedures in the classroom. The standpoints of the respondents in item 3, *There are opportunities to practice actual science exploration and experiments*, and item 2, *Real-world applications in science teaching are evident*, denote that students are invited to come across learning where they can apply their theoretical knowledge into real world-situations. This fosters a deeper understanding of scientific concepts [14]. Furthermore, this situation cultivates students' critical thinking abilities, problem-solving skills, as well as their curiosity towards scientific phenomena [6,7,15].

Table 5 presents the perspectives of the respondents along technology integration in science education. The

grand mean of 3.46 (*strongly agree*) suggests that teachers integrate technology in science education vis-à-vis their philosophical and technological pursuits. The standpoints of the respondents in item 1, *There is accessibility and availability of technology resources*, and item 7, *Multimedia is used to enhance science explanations*, denote that there is a wide range of students who might have the opportunity to engage with the educational resources at hand, thus; potentially promoting inclusivity and equal access to educational materials.

Moreover, the use of multimedia to enhance science explanations implies the integration of various visual and interactive elements (such as videos, animations, or simulations) alongside traditional teaching methods [16,17,18]. This approach can make scientific concepts more engaging, understandable, and accessible to learners with different learning styles or abilities [19,20]. It can also foster deeper comprehension and retention of complex scientific ideas by providing multiple avenues for understanding and exploration.

Table 5. Use of Technology in Science Education

Use of Technology in Science Education		Mean	Description
1	There is accessibility and availability of technology resources.	3.54	Strongly agree
2	There is integration of interactive digital simulations in science lessons.	3.43	Strongly agree
3	Online platforms for resources and assignments are employed.	3.39	Strongly agree
4	Technology to individualized learning needs are adapted.	3.41	Strongly agree
5	Virtual laboratories and experiments are integrated.	3.38	Strongly agree
6	Teachers are proficient in utilizing technology for instruction.	3.49	Strongly agree
7	Multimedia is used to enhance science explanations.	3.52	Strongly agree
8	Technology use is aligned with curriculum goals.	3.51	Strongly agree
9	Students are encouraged to use advanced technologies for research and projects.	3.48	Strongly agree
10	Emerging technologies (e.g., augmented reality, virtual reality, artificial intelligence models) are integrated in science education.	3.47	Strongly agree
Grand Mean		3.46	Strongly agree

Table 6 presents the perspectives of the respondents towards assessment and feedback in science education. The grand mean of 3.53 (*strongly agree*) suggests that teachers provide a functional assessment and feedback to their activities and procedures in the classroom. The standpoints of the respondents in item 2, *Formative assessments are used to guide instruction*, and item 10, *Assessment data are used for program improvement*, denote that the teachers are regularly employing assessment methods throughout the learning process to gauge students' understanding and progress. It can be noted further that these assessments are not just for grading but are also utilized to understand where students are struggling or excelling, allowing teachers to adjust their instruction accordingly [5,7,21]. Hence, this promotes a more adaptive and responsive teaching approach.

Moreover, this indicates a broader application of assessment results instead of just focusing on individual

student performance [22,23]. Thus, this implies that schools or educational programs analyze assessment data systematically to identify trends, areas needing improvement, or effective teaching methods. This data-driven approach enables institutions to refine their curricula, teaching strategies, and support systems to enhance overall learning outcomes [24,25].

Table 6. Assessment and Feedback in Science Education

Assessment and Feedback in Science Education		Mean	Description
1	There is clarity of assessment criteria and rubrics.	3.50	Strongly agree
2	Formative assessments are used to guide instruction.	3.59	Strongly agree
3	There is frequency and diversity of assessment methods (e.g., quizzes, projects, presentations).	3.57	Strongly agree
4	There is timeliness and quality of feedback provided to students.	3.50	Strongly agree
5	Self-assessment and peer assessment are used	3.51	Strongly agree
6	Assessments are always aligned with learning objectives.	3.57	Strongly agree
7	Authentic assessments that mirror real-world scientific practices are included	3.53	Strongly agree
8	Students are encouraged to reflect on their learning progress.	3.58	Strongly agree
9	Alternative assessment strategies to accommodate diverse student needs are encouraged	3.55	Strongly agree
10	Assessment data are used for program improvement.	3.59	Strongly agree
Grand Mean		3.53	Strongly agree

Table 7. Hands-on Practices in Science Education

Hands-On Practices in Science Education		Mean	Description
1	A well-equipped laboratory facility is provided.	3.41	Strongly agree
2	Hands-on experiments and activities are required in every lesson	3.52	Strongly agree
3	Practical experiences into the curriculum are integrated	3.56	Strongly agree
4	Students are encouraged to design and conduct experiments.	3.53	Strongly agree
5	Hands-on learning opportunities like programs and activities are provided	3.50	Strongly agree
6	Safety and ethical considerations in hands-on practices are emphasized	3.57	Strongly agree
7	Scientific exploration and innovation are encouraged	3.57	Strongly agree
8	Inquiry-based learning in hands-on activities is used	3.55	Strongly agree
9	Problem-solving skills are integrated in practical experiences.	3.59	Strongly agree
10	Hands-on practices align with scientific inquiry and discovery.	3.58	Strongly agree
Grand Mean		3.54	Strongly agree

Table 7 presents the hands-on practices of the respondents in science education. The grand mean of 3.54 (*strongly agree*) suggests that teachers are in a stride of providing hands-on activities among their learners particularly in science. The standpoints of the respondents in item 9, *Problem-solving skills are integrated in practical experiences*, and item 10, *Hands-on practices align with scientific inquiry and discovery*, denote that learners are exposed to real-world situations or scenarios where they

must apply critical thinking, analysis, and creative problem-solving techniques [6,7,26]. By embedding these challenges into the learning process, students have the opportunity to develop and refine their problem-solving abilities in a contextually relevant manner [26,27].

Furthermore, these emphasize the connection between practical experiences and the scientific process. This means that the hands-on activities provided to students are not just arbitrary exercises but are designed to mimic or reflect the methods used in scientific inquiry [28,29]. Students engage in activities that encourage exploration, hypothesis testing, experimentation, and the application of scientific principles [2,3,30]. Hence, this approach aims to cultivate a deeper understanding of scientific concepts while simultaneously honing problem-solving skills in a practical setting [1,6,7].

2. Comparative Analysis on the Critical Perspectives, Theoretical Foundations, Practical Teaching, Technology Integration, Assessment, and Hands-on Practices in Science Education

Presented in Table 8 are the critical perspectives, theoretical foundations, practical teaching, technology integration, assessment, and hands-on practices in science education when the respondents are grouped by sex. It shows that males and females are comparable in their vouched agreement on critical perspectives, practical teaching, and technology integration, while they are incomparable in terms of their theoretical foundations, assessment and feedback, and hands-on practices with the female-teachers to be better off in the delivery of the three parameters. Thus, this suggests that there is gender-based distinctions in the perceptions of theoretical foundations, assessment and feedback practices, and hands-on teaching approaches [5,6]. Female teachers are considered to excel or be more effective in delivering education in these specific aspects.

Presented in Table 9 are the critical perspectives, theoretical foundations, practical teaching, technology integration, assessment, and hands-on practices in science education when the respondents are grouped by subject level taught. It presents that there is a general consensus or agreement among respondents in several aspects of teaching and education across various educational levels. These aspects include critical perspectives, theoretical foundations, technology integration, assessment, and hands-on practices. In these areas, teachers from different levels (elementary, secondary, and tertiary) share comparable views or approaches.

However, the notable difference emerges in practical teaching. While secondary and tertiary level teachers show similar perspectives in practical teaching methods, elementary teachers' views significantly differ, particularly when compared to tertiary science teachers. This discrepancy suggests that the approach or perception of practical teaching varies notably between elementary educators and those teaching at higher levels.

This discrepancy might imply differences in the way practical teaching is understood or executed at different educational levels [19]. It could also highlight potential areas for alignment or improvement in practical teaching methodologies, especially between elementary and tertiary education, to ensure a more cohesive educational experience for students transitioning through different levels of schooling.

Table 8. Critical Perspectives, Theoretical Foundations, Practical Teaching, Technology Integration, Assessment, and Hands-on Practices in Science Education when the respondents are grouped by Sex

	Science Education	Male	Female	t-value	p-value
1	<i>Critical Perspectives in Science Education</i>	3.46	3.56	1.474	.082
2	<i>Theoretical Perspectives in Science Education</i>	3.43	3.56	2.159	.032*
3	<i>Practical Teaching Experiences in Science Education</i>	3.51	3.61	1.654	.100
4	<i>Use of Technology in Science Education</i>	3.40	3.49	1.317	.190
5	<i>Assessment and Feedback in Science Education</i>	3.46	3.60	2.355	.020*
6	<i>Hands-on Practices in Science Education</i>	3.46	3.59	2.054	.041*

*significant at .05 level

Presented in Table 10 are the critical perspectives, theoretical foundations, practical teaching, technology integration, assessment, and hands-on practices in science education when the respondents are grouped by education. It shows that there are no significant differences on the responses of the respondents across all education levels. However, it can be noted that BS-degree holders hold the lowest numerical answers when compared to their counterparts in the Master's and doctorate levels. This suggests that, overall, there are no substantial differences in the responses among educators across various education levels. However, there is a notable distinction when considering the educational attainment of the respondents.

Table 9. Critical Perspectives, Theoretical Foundations, Practical Teaching, Technology Integration, Assessment, and Hands-on Practices in Science Education when the respondents are grouped by Subject Level Taught

	Science Education	Elementary Science(A)	Secondary Science (B)	Tertiary Science (C)	F-value	p-value
1	<i>Critical Perspectives in Science Education</i>	3.49	3.55	3.53	.404	.688
2	<i>Theoretical Perspectives in Science Education</i>	3.47	3.56	3.50	.957	.386
3	<i>Practical Teaching Experiences in Science Education</i>	3.51AB	3.55BC	3.67CB	3.136	.046*
4	<i>Use of Technology in Science Education</i>	3.42	3.40	3.56	2.208	.113
5	<i>Assessment and Feedback in Science Education</i>	3.52	3.60	3.54	.643	.527
6	<i>Hands-on Practices in Science Education</i>	3.48	3.55	3.60	1.264	.285

*significant at .05 level; similar letters within rows are comparable

Table 10. Critical Perspectives, Theoretical Foundations, Practical Teaching, Technology Integration, Assessment, and Hands-on Practices in Science Education when the respondents are grouped by Education

	Science Education	BS	MA/MS/MAT	PhD/EdD	F-value	p-value
1	<i>Critical Perspectives in Science Education</i>	3.50	3.52	3.79	3.031	.051
2	<i>Theoretical Perspectives in Science Education</i>	3.49	3.51	3.76	2.446	.089
3	<i>Practical Teaching Experiences in Science Education</i>	3.54	3.58	3.81	2.460	.088
4	<i>Use of Technology in Science Education</i>	3.42	3.47	3.73	2.246	.109
5	<i>Assessment and Feedback in Science Education</i>	3.51	3.58	3.76	2.203	.113
6	<i>Hands-on Practices in Science Education</i>	3.50	3.56	3.76	2.061	.130

Table 11. Critical Perspectives, Theoretical Foundations, Practical Teaching, Technology Integration, Assessment, and Hands-on Practices in Science Education when the respondents are grouped by Academic Rank

	Science Education	SST/T (A)	MT (B)	HT (C)	TED (D)	F-value	p-value
1	<i>Critical Perspectives in Science Education</i>	3.42	3.54	3.47	3.53	.714	.545
2	<i>Theoretical Perspectives in Science Education</i>	3.38	3.55	3.45	3.45	1.373	.252
3	<i>Practical Teaching Experiences in Science Education</i>	3.40 A	3.56 BCD	3.52 CBD	3.67 DBC	3.130	.027*
4	<i>Use of Technology in Science Education</i>	3.16 A	3.45 B	3.57 CD	3.56 DC	4.294	.006*
5	<i>Assessment and Feedback in Science Education</i>	3.51	3.57	3.57	3.54	.165	.920
6	<i>Hands-on Practices in Science Education</i>	3.36	3.54	3.58	3.59	1.754	.157

*significant at .05 level; similar letters within rows are comparable

While there might not be statistically significant differences in the overall responses across education levels, there seems to be a trend where individuals holding BS degrees tend to provide lower numerical ratings or responses compared to those with higher degrees such as Master's or Doctorate levels. This pattern implies that there might be a correlation between higher educational attainment and more favorable or positive responses in the surveyed aspects. Those with advanced degrees (Master's and Doctorate) might demonstrate a tendency to rate certain educational elements more positively compared to their counterparts with Bachelor's degrees. This discrepancy in ratings could stem from various factors, including deeper knowledge, experience, or different perspectives gained through higher levels of education [7].

Presented in Table 11 are the critical perspectives, theoretical foundations, practical teaching, technology integration, assessment, and hands-on practices in science education when the respondents are grouped by academic rank. Among the six parameters, two posted significant differences - *the use of technology* and *practical teaching experiences* in science education. For the practical teaching experiences: There are significant differences between the SST (Science Specialist Teachers) and Teacher holders, particularly when compared to their counterparts in the MT (Master Teachers), HT (Head Teachers), and Teacher-Educators (TED). This suggests that the perspectives or approaches towards practical teaching experiences in science education differ notably between these groups. The SST and Teacher holders' viewpoints significantly contrast with those of MTs, HTs, and TEDs.

Similarly, there are significant differences between the SST and Teacher holders compared to the MT group, as

well as the HT and TED groups, regarding the use of technology in science education. Moreover, the SST and Teacher holders express significantly lower viewpoints or perspectives on technology integration compared to the MTs, HTs, and TEDs. These differences in perceptions between different groups, especially regarding technology integration and practical teaching experiences, could reflect varying levels of exposure, training, or understanding of these aspects within the context of science education [10,14,29]. It might also indicate potential areas for improvement or targeted support in enhancing technology integration and practical teaching methods across different roles or educator categories within the field of science education.

4. Conclusion and Future Works

Based on the findings of the study, the following are concluded:

1. The widespread agreement among respondents across multiple dimensions of science education suggests a promising scenario for employment and seamless integration of these facets across all educational levels—elementary, secondary, and tertiary.
2. While both male and female educators agree on certain aspects like critical perspectives, practical teaching, and technology integration, the notable differences in theoretical foundations, assessment, and hands-on practices indicate a potential for learning from each other's strengths, especially where female teachers excel.

3. The alignment in viewpoints among teachers from different levels in critical aspects of science education is encouraging. However, the divergence in practical teaching methods, especially with elementary teachers differing significantly from tertiary educators, suggests a need for targeted strategies to bridge these gaps.
4. The pattern of lower responses from Bachelor's degree holders compared to those with higher academic degrees highlights the potential correlation between educational attainment and perspectives in science education. This suggests a potential emphasis on ongoing education and professional development.
5. The significant differences in perspectives between Science Specialist Teachers, Teacher holders, and other categories like Master Teachers, Head Teachers, and Teacher-Educators suggest varying ideologies or approaches towards practical teaching experiences and technology integration. This indicates the need for collaboration and sharing of best practices across these groups to enhance overall teaching quality.

Based on the conclusions of this study, the following future works are forwarded:

1. Conduct qualitative research to delve deeper into why certain groups, especially those with different educational levels or genders, hold distinct perspectives. Understanding the underlying reasons could inform targeted interventions.
2. Develop specialized training programs that address the areas where there are notable differences among educators. This could involve workshops, seminars, or online courses to promote sharing of best practices and knowledge exchange.
3. Conduct longitudinal studies to track changes in perceptions and practices over time. This could provide insights into the effectiveness of interventions and educational advancements, especially regarding the correlation between educational attainment and teaching perspectives.
4. Facilitate collaborative projects or initiatives involving educators from different levels (elementary, secondary, tertiary) to foster mutual learning and alignment of teaching methodologies, especially in practical teaching methods.
5. Given the significant differences in views regarding technology use, explore effective ways to integrate technology into science education across all educator categories. This might involve training sessions on utilizing tech tools or implementing innovative teaching methods.
6. Further investigate the gender-based differences in teaching approaches and assess how integrating diverse perspectives can enhance the overall quality of science education. Implement strategies to encourage cross-gender learning and collaboration.
7. Encourage educators to conduct action research within their classrooms, exploring the impact of different teaching methods on student engagement and learning outcomes. Sharing these findings could benefit the broader educational community.
8. Analyze the implications of these findings for educational policy-making. These insights could

inform curriculum development, teacher training programs, and resource allocation in science education.

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