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Research paper

A Developmental Framework for Managing Science Instruction: Insights from Selected Teacher Education Institutions in Batangas

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Abstract

The attainment of quality management in science instruction depends largely on the management system adopted by Teacher Education Institutions (TEIs). As producers of future educators, TEIs are responsible for training competent and well-prepared teachers. This study examined how science instruction is managed in selected TEIs in Batangas, focusing on administrators' and science teachers' assessments of goals and objectives, instructional practices, learning modalities, learning experiences, faculty attributes, and research and evaluation. It also explored how the management functions—planning, organizing, staffing, directing, and controlling—are implemented and the problems encountered in managing science instruction.

Using the descriptive method, data were gathered through questionnaires, interviews, and focus group discussions involving 21 administrators and 71 science teachers. Statistical tool used was the weighted mean. Results revealed that goals and objectives and faculty attributes were strong areas, while instructional practices, learning experiences, and research and evaluation required improvement. Problems encountered included limited scholarship grants, and inadequate laboratory tools, reagents, and safety equipment. These findings highlight the need for improved management support and the adoption of the proposed developmental framework to enhance science instruction in TEIs in Batangas.

Keywords: *Administrators; Developmental Framework; Science Instruction; Science Teachers; Teacher Education.*

1. Introduction

Science and technology are recognized as foundational elements in national development, and the Philippine Constitution underscores their prioritization in education, research, and innovation. Higher education institutions, particularly Teacher Education Institutions (TEIs), are charged with preparing future teachers who can effectively translate these priorities into teaching practice . Recent studies underscore that advancing science and technology is foundational to national development, with improved science education seen as a strategic driver for innovation, workforce readiness, and socio-economic progress. In the Philippine context, empirical research highlights persistent challenges in science instruction and teacher preparation that affect educational quality and the nation's capacity to meet development goals. Case studies in science and technology education across Philippine schools emphasize the importance of teacher qualifications, instructional strategies, and professional training in effectively delivering science curricula, pointing to gaps in teacher preparedness that must be addressed to achieve broader educational outcomes [1]. Scholarly work on STEM teacher experiences also reveals that competencies in technological pedagogical content knowledge (TPACK) are critical for preparing future educators to integrate 21st-century skills into science and technology teaching, thereby aligning teacher preparation with national priority areas of innovation and workforce development [2]. Moreover, research investigating the level of technological implementation in science instruction found that effective use of digital tools and technology in science classrooms contributes to improved student achievement and instructional engagement, again pointing to the need for TEIs to strengthen teacher preparation in digital and technology-enhanced teaching methods [3]. In addition, institutional leadership functions such as planning, organizing, staffing, directing, and controlling play a significant role in shaping educational outcomes. Effective educational leaders who provide clear strategic direction, monitor institutional progress, and support instructional improvement create conditions that enhance teaching and learning quality[4]. Together, these findings suggest that TEIs play a pivotal role in operationalizing national science and technology priorities by preparing future teachers who are competent in both content and innovative instructional practices.

Science instruction is also greatly influenced by the kind of management of TEIs, which in turn is connected to the quality of the teaching and learning processes. According to Aquino [5], the instructional practices are the key processes needed to achieve the desired student outcomes for an educational program. In addition, research in science education, according to Sindhu [6] is important, because it leads to

progress in science instruction, which further leads to progress in science. Recent literature emphasizes the critical role of professional development (PD) in enhancing science teaching quality and instructional management. Systematic evidence suggests that sustained and collaborative PD activities, such as training courses, coaching, and professional learning communities, are effective than improving teachers' competencies and classroom practices [7]. Furthermore, reviews of STEM-focused PD highlight the importance of discipline-specific training that integrates content knowledge with pedagogical strategies to support effective science teaching [8].

However, in spite of the concerted efforts in improving science instruction, science education is still not meeting the challenge of achieving full scientific literacy. Empirical studies have identified several obstacles affecting science teaching quality in TEIs, including weak outcomes-based instruction [9], insufficient laboratory resources [10], and inconsistent implementation of instructional modalities [11]. Moreover, findings suggest that faculty research engagement and professional development enhance instructional quality, but these are not systematically integrated into management systems [12], [13]. Contextualizing science teaching through local relevance further boosts engagement and achievement, yet remains unevenly practiced [14].

This study addresses this gap by examining how TEIs in Batangas manage science instruction, encompassing both administrative and pedagogical dimensions. Drawing on survey responses, interviews, and focus group discussions with administrators and science faculty, this study explore how administrators and science teachers assess science instruction in selected Teacher Education Institutions (TEIs), focusing on several key areas, including the alignment of goals and objectives, instructional practices and learning modalities, learning experiences, faculty attributes, and research and evaluation. It also examines how various aspects of the management of science instruction are carried out, specifically in terms of planning, organizing, staffing, directing, and controlling. Additionally, the study aims to identify the problems encountered in the management of science instruction. Finally, it seeks to propose a developmental framework for science instruction based on the findings. The goal is to offer a practical, evidence-based management framework that bridges educational management theory with science pedagogy within the Philippine TEI context. Unlike previous studies that focus on isolated aspects of teaching or administration, this research concurrently addresses both domains, delivering a unified framework tailored to local needs. The proposed model has the potential to guide policy-makers, educators in TEIs, and institutional leaders toward sustainable improvements in science instruction, not only in Batangas, but potentially across similar educational settings.

2. Methodology

The study employed the descriptive method of research, which involves collecting data to answer questions related to the subject of the investigation. For this purpose, the researcher utilized a researcher-made questionnaire as the main data-gathering instrument. Informal interviews and focus group discussions were also conducted to obtain comprehensive evaluative data and address the problems raised in the study.

The respondents of the study included TEI administrators—comprising college deans, associate deans, and department chairs—as well as science teachers from selected public and private TEIs in Batangas. The total number of administrators and science teachers from each of the eleven TEIs was included in the study. There were 21 administrators, consisting of 11 deans, 3 associate deans, and 7 department heads, and 71 science teacher respondents. No sampling was done, as the number of administrators and science teachers was deemed sufficient to meet the research requirements.

The researcher wrote a formal letter to the Presidents of the respective Teacher Education Institutions (TEIs) in Batangas to request approval for the conduct of the study. Upon approval, coordination with the Office of Academic Affairs was undertaken to gain access to both administrators and science teachers for the administration of the questionnaires.

Participation in the study was entirely voluntary. All respondents were provided with an informed consent form that clearly stated the purpose of the study, the procedures involved, their right to refuse or withdraw at any time without penalty, and an assurance that their responses would remain anonymous and confidential. The confidentiality of both participants and institutions was strictly maintained throughout the research process, in accordance with standard research ethics protocols.

The gathered data were tabulated, analyzed, and interpreted in light of the stated research problems. The statistical tool used was the weighted mean.

3. Results and Discussion

3.1. Science instruction in the teacher education institutions

3.1.1. Goals and objectives

Table 1 presents the assessment on science instruction along goals and objectives of science teaching in TEIs.

Table 1: Science Instruction along Goals and Objectives

Items		Administrators		Teachers	
		WM	VI	WM	VI
1	Support the national development goals of science instruction through teaching	3.91	SA	3.77	SA
2	Focus on effective teaching which inspire students to develop their interest in the study of science	3.90	SA	3.75	SA
3	Gear toward the acquisition of knowledge, gaining of skills, development of attitude that can insure scientific literacy	3.90	SA	3.72	SA
4	Concentrate on both physical and biological sciences	3.67	SA	3.51	SA
5	Give more attention on physical science than to biological science for science major curriculum	3.28	A	2.41	D
6	Provide direction on how students will gain functional and productive skills through science teaching	3.90	SA	3.83	SA
7	Provide guidelines to attain the targets of science teaching	3.86	SA	3.70	SA
8	Focus on the necessary skills the students need in everyday activities	3.86	SA	3.66	SA
9	Upgrade the standard of science instruction to increase student's know-how	3.90	SA	3.68	SA
10	Develop among the students' scientific attitudes and values to adopt to the changing needs of needs of the society	3.90	SA	3.76	SA
11	Consider objectives as the foundation upon which lessons can be built and as a tool to make learners reach its goals	3.71	SA	3.70	SA
	Composite Mean	3.72	SA	3.59	SA

Legend: SA - Strongly Agree A- Agree D – Disagree.

The table reveals that administrators and science teachers strongly agreed that science instruction supports the national development goals of science education and provides direction on how students can gain functional and productive skills. This implies that TEIs' science curricula and instruction can nurture scientific literacy, aptitude, skills, and values essential for students to face future challenges and thrive in a fast-changing society. This supports the findings of Maalihan [15], who noted that the teacher education program recognizes its responsibility in preparing pre-service teachers to undertake various roles and functions and to meet global competitiveness.

3.1.2. Instructional practices and learning modalities

Table 2 presents the assessment on science instruction in terms of instructional practices and learning modalities.

Table 2: Science Instruction along Instructional Practices and Learning Modalities

Items		Administrators		Teachers	
		WM	VI	WM	VI
1	Give more attention to lecture method than to laboratory practices	2.62	A	2.59	A
2	Allow reporting methods of teaching in science Instruction	3.00	A	2.87	A
3	Address the needs of individual student to ensure full participation in science activity	3.62	SA	3.54	SA
4	Allow teachers to use different methods/ strategies to cope up with the learning performance of the students	3.62	SA	3.72	SA
5	Use field trip to expose students to the real nature science	3.05	A	3.08	A
6	Use investigative process and procedure to gather and evaluate data in order to seek solution to problem	3.76	SA	3.55	SA
7	Consider students to learn best by doing rather than listening or watching	3.62	SA	3.59	SA
8	Anticipate that students vary with one another in a way they use their senses in learning	3.20	A	3.41	A
9	Use cooperative learning method to capitalize in sharing ideas, information and skills among members of the group	3.38	A	3.44	A
10	Motivate students to develop sense of responsibility and cooperativeness through group work	3.86	SA	3.79	SA
11	Encourage students to explore on their own while performing practical activities	3.48	A	3.55	SA
12	Develop the student skill to manipulate laboratory equipment used in experimentation	3.71	SA	3.62	SA
Composite Mean		3.41	A	3.40	A

Legend: SA - Strongly Agree A – Agree.

From the table, both administrators and science teachers strongly agreed that instructional practices and learning modalities motivate students to develop a sense of responsibility and cooperation through group work.The finding indicates that group work engages students in working as a team to accomplish tasks through collaborative interaction. This was supported by participant interviews and substantiated by the FGD, which highlighted the effectiveness of working together and sharing ideas to achieve a common goal. The result aligns with Ebrahim [16], who found that group work fosters cooperative learning and leads to more positive gains in students' achievement and social skills than a teacher-centered approach.

3.1.3. Learning experiences

Table 3 presents the assessment in science instruction along learning experiences.

Table 3: Science Instruction Along Learning Experiences

Items		Administrators		Teachers	
		WM	VI	WM	VI
1	Emphasize comprehensively on lecture rather than on laboratory method	2.71	A	2.75	A
2	Determine how academic subject can be learned in the classroom and applied to real life situations	3.57	SA	3.58	SA
3	Compare those obtained through games and interactive software application	3.00	A	3.01	A
4	Include those gained through listening in lecture and doing assignments	3.29	A	3.48	A
5	Enhance by connecting past experiences to current lesson	3.71	SA	3.56	SA
6	Consider the learning of students in their own without the direct supervision of the teacher	3.00	A	3.03	A
7	Include on-line application that student undertakes to develop skills on the use of technology	2.86	A	3.11	A
8	Enrich through doing assignments, exercises, seat works, and other activities	3.76	SA	3.63	SA
9	Include learning gained through attendance in conferences, seminar-workshop and other school activities	3.38	A	3.42	A
Composite Mean		3.25	A	3.28	A

Legend: SA - Strongly Agree A – Agree.

The table shows that administrators and science teachers strongly agreed that learning experiences are enriched through assignments, exercises, seatwork, and other activities. Such findings emphasize the importance of assigning students additional tasks to reinforce the concepts learned during classroom discussions. These activities provide opportunities for learners to work independently, allowing them to deepen their understanding at their own pace. This supports the idea of Zimmerman [17] in his self-regulated learning framework that assignments and similar tasks serve as extensions of classroom learning, promoting independence, responsibility, and self-discipline among students. Moreover, Reigeluth and Carr-Chellman [18] assert that exercises, drills, and other reinforcement activities contribute to mastery learning by providing opportunities for practice and feedback. These activities, therefore, play a vital role not only in reinforcing classroom lessons but also in preparing learners for subsequent learning experiences.

3. 1.4. Faculty attributes

The assessment of science instruction along faculty attributes is presented in Table 4.

Table 4: Science Instruction Along Faculty Attributes

Items		Administrator		Teacher	
		WM	VI	WM	VI
1	Professionally qualified to teach science subjects	3.86	SA	3.68	SA
2	Have obtained relevant undergraduate and graduate	3.67	SA	3.37	A
3	Have acquired experiences in teaching science	3.90	SA	3.56	SA

4	Uphold teaching standard to ensure that their teachings meets such expectation	3.90	SA	3.73	SA
5	Possess mastery of the subject matter	3.81	SA	3.69	SA
6	Use effective disciplinary measures that can promote positive behavior and conducive classroom environment	3.85	SA	3.72	SA
7	Support and guide students with varied interests, abilities and experiences	3.76	SA	3.70	SA
8	Confer collaboratively with other teachers within the school to improve their quality of science instruction	3.76	SA	3.66	SA
Composite Mean		3.81	SA	3.64	SA

Legend: SA - Strongly Agree A – Agree.

As shown in the table, both administrators and teachers strongly agreed that faculty members uphold teaching standards to ensure that their teaching meets such expectations. This finding is not surprising, since TEIs are mandated to produce graduates with academic and professional competence. Yam [19] supports this finding, revealing that science instruction in TEIs prepares prospective science teachers to cope with the changing demands of the educational landscape and work with dedication toward enhancing science instruction in teacher education institutions. These are regarded as strengths that contribute to the attainment of science education goals. Such a view also aligns with Scherer [20], who emphasized that faculty members inspire students through their commitment to upholding professional teaching standards.

3.1.5. Research and evaluation

Table 5 presents the assessment of science instruction in terms of research and evaluation.

Table 5: Science Instruction Along Research and Evaluation

Items		Administrators		Teachers	
		WM	VI	WM	VI
1	Enhance teachers' understanding and practice in profession through involvement in action research	3.63	SA	3.38	A
2	Empower teachers through research to work collaboratively with one another	3.33	A	3.21	A
3	Apply research-based strategies in classroom setting to make teaching more effective	3.14	A	3.24	A
4	Conduct interviews and focus group discussions small group conferences to gather data necessary to establish relationship between variables under study	2.67	A	2.70	A
6	Serve as basis to improve teaching standard and quality of teaching-learning process	3.48	SA	3.37	A
6	Conduct case study on issues relevant to science Instruction	3.62	SA	3.04	A
8	Present/publish the finding of action researches in a manner that can be shared by colleagues for their professional growth	3.48	SA	3.37	A
9	Examine new research findings, methods, and approaches which can help enhance the teaching profession	3.33	A	3.24	A
10	Involve students to conduct various scientific investigations to expose them to diverse ideas, resources and technologies	3.90	SA	3.27	A
Composite Mean		3.40	A	3.22	A

Legend: SA - Strongly Agree; A – Agree.

It is reflected in the table that administrators strongly agreed that students were involved in the conduct of various scientific investigations to explore diverse ideas, resources, and technologies. Meanwhile, teachers agreed that science instruction enhances their understanding and professional practice through involvement in action research. This highlights the role of research in science instruction and its connection to the professional growth and development of teachers. This finding is supported by interviews with the respondents and was further strengthened in the FGD, where it was emphasized that conducting scientific research not only familiarizes students with the scientific method but also serves as a motivating factor for their future engagement in research.

3.2. Management of science instruction in teacher education institutions

3.2.1. Planning

Table 6 presents the assessment in management of science instruction along planning.

Table 6: Management of Science Instruction in Terms of Planning

Items		Administrators		Teachers	
		WM	VI	WM	VI
1	Assess the needs of the science department before preparing any plans in science instruction	3.81	VO	3.51	VO
2	Set goals and objectives of every school plans and program of the department	3.76	VO	3.61	VO
3	Prepare guidelines to attain the objectives of science instruction	3.86	VO	3.62	VO
4	Involve teachers in planning science curriculum content well as extra-curricular activities	3.62	VO	3.56	VO
5	Empower teachers to participate in decision-making in planning school activities	3.76	VO	3.55	VO
6	Empower teachers to design future course of action for the good of the department	3.71	VO	3.66	VO
7	Prepare plans/strategies to accomplish objectives and arrive at desired outputs	3.52	VO	3.61	VO
8	Plan ahead of time the acquisition of teaching materials and other learning resources so as to be provided in the time needed	3.52	VO	3.54	VO
9	Set goals of the science instruction as well as allocate appropriate human and material resources as well	3.71	VO	3.54	VO
Composite Mean		3.70	VO	3.58	VO

Legend: VO - Very Often.

As reflected in the table, administrators and science teachers very often prepare guidelines to attain the objectives of science instruction, and to empower science teachers to design future course of action for the goals of the department. This is a clear indication of the compliance of teachers to plan and organize future courses on what action of what they need to do and implement in order to manage classroom effectively. This is parallel to the findings of Marzano [21] which cited that the role of teachers must be well-planned and organized systematically so as to make the choice of effective instructional strategy to facilitate students' learning and effective classroom environment.

3.2.2. Organizing

Table 7 presents the assessment on the management of science instruction in terms of organizing.

Table 7: Management of Science Instruction in Terms of Organizing

Items		Administrators		Teachers	
		WM	VI	WM	VI
1	See to it that the science department has formal organizational structure for science instruction	3.62	VO	3.49	VO
2	Orient teachers on the organizational set-up of science instruction	3.67	VO	3.48	O
3	Designate teacher to handle co-curricular activities according to their capacity and interest	3.71	VO	3.49	O
4	Assure that the work efforts of teachers are directed towards accomplishment of school tasks and objective	3.76	VO	3.62	VO
5	Assist science teachers in organizing their classes and other related science activities	3.81	VO	3.52	VO
6	Identify resources that science teachers use in their classes and organization activities	3.76	VO	3.61	VO
7	Distribute work, function and personal supervision equally and fairly	3.67	VO	3.49	O
8	Set teachers' meetings to thresh out problems that arise problems that arise in the teaching and Learning process.	3.71	VO	3.55	VO
Composite Mean		3.71	VO	3.53	VO

Legend: VO - Very Often O – Often.

Table revealed that the administrators very often assist science teachers in organizing their classes and other related activities, while science teachers assure that their work is directed towards the accomplishment of school tasks and objectives. It only means that the organizing entails assistance from administrators to maintain conducive classroom environment to optimize quality teaching and performance. This also means that the success of an organization is dependent on the submissiveness of teachers to perform the tasks assigned to them and in contributing the best effort in the teaching performance.

3.2.3. Staffing

Table 8 presents the assessment on the management of science instruction in the TEIs in terms of staffing.

Table 8: Management of Science Instruction in Terms of Staffing

Items		Administrators		Teachers	
		WM	VI	WM	VI
1	Update records about the needs for qualified teachers every beginning of the semester for each school year	3.81	VO	3.51	VO
2	Study the qualification of science teachers to match with the need of the department	3.71	VO	3.50	VO
3	Keep looking for science teacher for possible recruitment in the future	3.52	VO	3.45	O
4	See to it that teachers are assigned to science subject of their individual expertise	3.61	VO	3.33	O
5	Study the potentialities of teachers in science department for future reference	3.63	VO	3.44	O
6	Encourage new science teachers specially to enroll on graduate courses to upgrade their education qualification	3.81	VO	3.55	VO
7	Measure the performance of teaching staff against established standard	3.71	VO	3.51	VO
8	Focus on maintaining and improving the teaching and the non-teaching personnel in the department	3.81	VO	3.49	O
9	Appraise and develop teaching personnel to fill the roles designed into the structure	3.76	VO	3.56	VO
Composite Mean		3.71	VO	3.48	VO

Legend: VO - Very Often O – Often.

As reflected in the table, administrators very often update records on the needs of qualified teachers at the beginning of every semester, encourage new science teachers to pursue graduate studies to improve their educational qualifications, and prioritize maintaining and enhancing both teaching and non-teaching personnel within the department. These practices illustrate the administration's effort to sustain instructional quality and ensure that personnel remain aligned with institutional standards and program requirements. Likewise, teacher-respondents acknowledge the need to appraise and develop teaching personnel to effectively assume roles within the organizational structure. This alignment of perspectives between administrators and teachers suggests a shared recognition of the importance of continuous professional development and workforce planning. Such practices reflect a proactive approach to human resource management in education, where investment in faculty growth is seen as a means to improve instructional delivery, strengthen departmental performance, and support the long-term goals of the institution. This is parallel to the findings of Aquino [22] that the quality and quantity of teachers are contributing factors to the teaching competence and performance in science.

3.2.4. Directing

The assessment of the management of science instruction in terms of directing is presented in Table 9.

Table 9: Management of Science Instruction in Terms of Directing

Items		Administrators		Teachers	
		WM	VI	WM	VI
1	See to it that every member of the department works towards attainment of the goals of science instruction	3.81	VO	3.50	VO
2	Direct science teacher to find ways and means to improve their skills in the teaching of science	3.71	VO	3.58	VO

3	Instruct, guide and see the performance of teacher and personnel achieve the predetermined goals	3.71	VO	3.52	VO
4	Lead teachers to participate actively in all activities of the department	3.81	VO	3.54	VO
5	Conduct relevant activities on how to improve performance based on quality standard	3.57	VO	3.28	O
6	See to it that human and material resources are utilized to accomplish the trifocal function of teaching, research and extension service	3.52	VO	3.34	O
7	Instruct science teachers to perform their job to the best of their ability	3.76	VO	3.59	VO
8	Conduct follow–up classroom observation for teacher to determine progress attained in previous observation	3.86	VO	2.46	O
Composite Mean		3.72	VO	3.35	O

Legend: VO - Very Often O – Often.

As reflected in the table, the administrators very often conducted follow-up classroom observation for teachers to determine the progress from previous observations. On the other hand, science teachers very often see to it that their administrators instruct science teacher to perform their jobs to the best of their ability. The results indicate that administrators very often conduct follow-up classroom observations to monitor instructional progress, while science teachers acknowledge that administrators encourage them to perform their duties to the best of their ability. This suggests the presence of a continuous and supportive instructional supervision system that promotes accountability and professional growth. Follow-up observations serve as a mechanism for identifying improvements from previous evaluations and providing timely instructional feedback, which research identifies as a key driver of teacher performance and classroom effectiveness [23].

3.2.5. Controlling

Table 10 presents the assessment in the management of science instruction in terms of controlling.

Table 10: Management of Science Instruction in Terms of Controlling

Items		Administrators		Teachers	
		WM	VI	WM	VI
1	Monitor the performance of science teacher to ensure the attainment of desired results	3.67	VO	3.51	VO
2	Take corrective action to any observed inadequacies of teaching staff in the performance duty	3.57	VO	3.41	O
3	Direct science undertakings to flow smoothly without deviation, alteration or disruption	3.62	VO	3.45	O
4	Regulate operation of the school activities in accordance with the objectives specified in the plans	3.62	VO	3.51	VO
5	Evaluate the science department operation performance to look for possible revisions or modifications	3.62	VO	3.37	O
6	Provide effective suggestions to meet the required standard performance	3.76	VO	3.42	O
7	See to it that the teacher/school personnel maintain quality performance on assigned task	3.81	VO	3.54	VO
8	Monitor the actual performance and compare to the standard level of performance	3.67	VO	3.48	VO
9	Minimize/avoid problems that would affect the efficiency of the operation of science instruction	3.76	VO	3.40	VO
Composite Mean		3.68	VO	3.45	VO

Legend: VO - Very Often O – Often.

The table reveals that both administrators and science teachers perceive that teachers and school personnel very often maintain quality performance on assigned tasks. This indicates a culture of accountability and high standards within the institution, where personnel consistently strive to meet expectations and fulfill their responsibilities effectively. Maintaining quality performance aligns with accreditation requirements, which emphasize the importance of competent and professional staff in achieving institutional goals, ensuring instructional excellence, and sustaining continuous improvement [24, [25]. Consistently high performance by teachers and personnel not only reflects adherence to established policies and standards but also demonstrates the institution's commitment to providing quality education and meeting benchmarks set by accrediting bodies. Such practices are critical in fostering an environment that supports student learning, institutional credibility, and the attainment of program outcomes.

3.3. Problems met in the management of science instructions

Table 11 presents the problems met in the management of science instruction.

Table 11: Problems Met in the Management of Science Instruction

Items		WM	VI
1	Lack of scholarship grant for some deserving but financially incapable teachers to continue graduate studies	2.45	Sometimes
2	Inadequate laboratory tools, chemical reagent supplies and safety equipment	2.40	Sometimes
3	Insufficient in-service training program to improve teachers' competence	2.38	Sometimes
4	Insufficient updated technology needed in teaching learning process	2.36	Sometimes
5	Inadequate learning resources like books and laboratory manuals	2.35	Sometimes
6	Absence of trained technician to help in the maintenance, preparation of reagents and for safe keeping of equipment and materials	2.33	Sometimes
7	Lack of interest of some students on science subject due to usual perception that they are difficult and uninteresting	2.31	Sometimes
8	Hesitation of some married teachers to pursue graduate study program due to family responsibility and priority	2.27	Sometimes
9	Inadequate library material references for supplementary readings of the students	2.16	Sometimes
Composite Mean		2.33	Sometimes

The table indicates that key challenges in managing science instruction include the lack of scholarship grants for teachers to pursue graduate studies, inadequacies in laboratory tools, equipment, and chemical supplies, as well as insufficient in-service training programs. These issues highlight resource constraints that can affect instructional quality and the professional growth of science teachers. To address these challenges, TEIs can integrate continuous improvement systems that systematically identify gaps, monitor instructional outcomes, and implement targeted interventions. For instance, TEIs can establish professional development plans that prioritize scholarship opportunities, ensuring that teachers continually update their knowledge and pedagogical skills.

Moreover, technology and digital resources can play a critical role in mitigating laboratory limitations. Virtual laboratories and simulation software can supplement physical lab activities, allowing students to conduct experiments in a controlled, cost-effective, and safe environ-

ment. Integrating these digital tools not only enhances scientific inquiry skills despite resource constraints but also supports the development of critical thinking and independent learning. By combining continuous improvement strategies with innovative technology integration, TEIs can ensure that science instruction remains high-quality and responsive to both teachers' and students' needs, ultimately promoting sustainable institutional growth and alignment with CHED accreditation standards.

3.4. Developmental framework to enhance science instruction

Figure 1 presents the proposed developmental framework for enhancing science instruction, which was crafted based on the findings of the study.

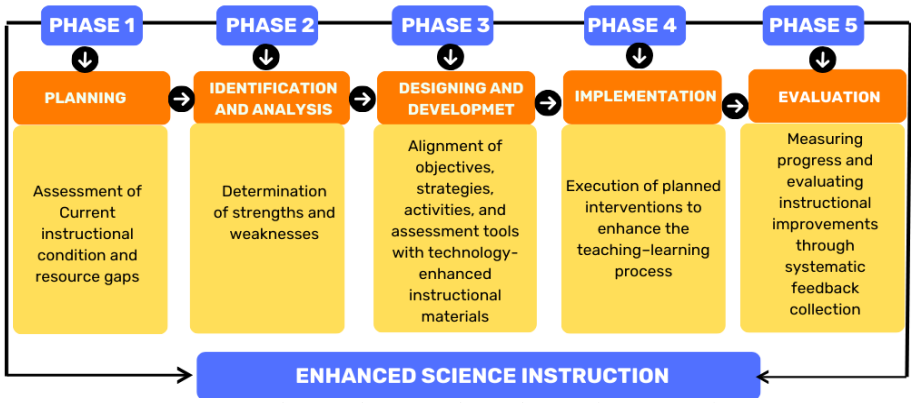

Fig. 1: Developmental Framework to Enhance Science Instruction.

The proposed Developmental Framework to Enhance Science Instruction consists of five interconnected phases that guide TEIs in improving instructional quality. The first phase, Planning, serve as the foundation for improvement by conducting thorough needs assessments, reviewing existing instructional practices, auditing laboratory resources, and identifying gaps between the current and desired states of science instruction. TEIs can operationalize this by administering surveys, reviewing curriculum requirements, and consulting faculty to gather baseline data. The second phase, Identification and Analysis, involves examining the collected data to determine strengths. This includes identifying strengths such as clear goals, qualified teachers, and established standards, as well as weaknesses in instructional practices, learning methods, learning experiences, research involvement, and management functions. TEIs can implement this phase by conducting program review sessions and data validation meetings, ensuring that instructional improvements are based on accurate and comprehensive information . The third phase, Designing and Development, focuses on formulating targeted interventions and preparing the necessary materials, including setting objectives, choosing strategies, structuring training programs, producing instructional guides, developing laboratory and digital resources, and training facilitators. Crafting training modules, preparing technology-enhanced materials, and organizing facilitator orientations are essential and require careful attention. The fourth phase, Implementation, serves as the execution stage where the designed interventions are put into action through training sessions, workshops, technology integration, and enhanced laboratory activities, with faculty applying new strategies and participating in professional development. During this phase, TEIs implement the initiatives by conducting scheduled programs and facilitating classroom-based innovations. Finally, the Evaluation phase measures the effectiveness of the interventions through assessment tools, feedback collection, instructional outcome reviews, and analysis of faculty and student performance. TEIs can carry out this phase through post-training evaluations, feedback surveys, and the systematic use of findings to strengthen subsequent program cycles. Together, these phases offer TEIs a practical and sustainable approach for the continuous improvement of science instruction. To support this process, TEIs and CHED may develop policies that promote structured enhancements in science teaching, ensuring alignment with both institutional goals and national standards. Furthermore, pilot-testing of the proposed framework in selected TEIs is recommended to evaluate its practicality and effectiveness before full-scale implementation.

4. Conclusion

The study revealed strong agreement between administrators and science teachers regarding the goals, objectives, and faculty attributes of science instruction. Areas such as instructional practices, learning modalities, learning experiences, and research and evaluation were identified as needing improvement. The management functions of planning, organizing, staffing, directing, and controlling were generally well implemented across the institution. However, key challenges such as limited scholarship grants, inadequate laboratory resources, and insufficient in-service training persisted. The proposed Developmental Framework to Enhance Science Instruction guides TEIs in improving science instruction management, faculty development, and student learning outcomes, ultimately supporting institutional excellence.

Declaration of AI Use in The Preparation of The Manuscript

The authors used ChatGPT to assist in language editing and improving the clarity of the manuscript. The authors reviewed, verified, and revised all content generated by the AI tool and take full responsibility for the integrity and accuracy of the final version.

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