

Examining Pre-Service Teachers' Reflective Narratives in Science 102: A Solo Taxonomy Approach to Pedagogical Growth and Instructional Decision-Making

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ABSTRACT: This study examines the reflective narratives of third-year pre-service science teachers enrolled in Science 102 at Dalubhasaan ng Lungsod ng San Pablo, focusing on lesson planning and instructional decision-making through the lens of the Structure of Observed Learning Outcomes (SOLO) taxonomy. Reflective practice is recognized as a cornerstone of teacher education, yet the depth and quality of student reflections often vary, ranging from procedural descriptions to more integrated pedagogical reasoning. To address this variability, the study employed a qualitative approach, collecting data through validated open-ended questionnaires and analyzing responses according to SOLO's hierarchical levels of cognitive complexity.

Findings indicate that while many pre-service teachers produced multistructural reflections, focusing primarily on isolated aspects of lesson design, only a smaller number progressed to relational and extended abstract levels, where theoretical concepts were meaningfully integrated and generalized into broader pedagogical reasoning. This developmental trajectory underscores both the potential and the constraints of reflective practice in advancing pedagogical growth.

The study underscores the need for evidence-based interventions that scaffold deeper reflection, enabling pre-service teachers to move beyond surface-level planning toward principle-driven instructional reasoning. Recommendations emphasize the integration of structured reflection tasks within lesson planning, alongside curriculum enhancements that deliberately align Science 102 content with reflective practice. Such measures are intended to scaffold deeper levels of cognitive engagement, enabling pre-service teachers to move beyond procedural planning toward more principle-driven instructional reasoning. By leveraging the SOLO taxonomy, teacher education programs can more effectively cultivate reflective, adaptive educators prepared to navigate the complexities of classroom instruction.

KEYWORDS: Preservice teachers, Reflective practice, Science 102, SOLO Taxonomy

INTRODUCTION

Reflective practice is fundamental to teacher education, enhancing Pre-service teachers' capacity to critically analyze their instructional choices and professional development (Li, 2025). In the realm of science education, reflection functions as both a mechanism for self-evaluation and a method for enhancing educational comprehension. Through reflective narratives, Pre-service teachers express their cognitive processes, assess their instructional decisions, and link theory to practice. Reflection serves to develop flexible, learner-centered educators adept at managing the intricacies of classroom instruction.

Lesson planning, an essential competency in teacher preparation, establishes the framework through which Pre-service instructors design teaching and foresee student engagement. Effective lesson planning necessitates coherence, connection with educational objectives, and consideration of varied learner requirements. The significance of lesson planning transcends mere technical preparation; it resides in the introspective analysis of the rationale behind instructional decisions (Seherrie & Mawela, 2021). In Science 102, third-year Pre-service teachers are required to construct lesson plans and reflect on their planning experiences, thereby incorporating pedagogical principles into their professional growth.

Notwithstanding the focus on reflective practice, the breadth and quality of student reflections frequently exhibit significant variability. Certain Pre-service teachers have a surface-level understanding, concentrating mostly on procedural elements of lesson design, whereas others start to incorporate more comprehensive pedagogical ideas and learner-centered approaches. This variability underscores the necessity for a systematic framework to study reflective narratives and differentiate across levels of cognitive complexity. In the absence of such analysis, the potential of reflection as a mechanism for professional development is inadequately leveraged.

The Structure of Observed Learning Outcomes (SOLO) taxonomy, as described by Adenji, et. al (2022), provides a useful

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framework for assessing the quality of student reflections. SOLO serves as a framework for evaluating learning outcomes by classifying responses based on their depth of comprehension, from prestructural (minimal engagement) to extended abstract (integrated and generalized thinking). When applied to reflective narratives, SOLO allows educators to discern the progression of Pre-service teachers from disjointed insights to comprehensive, principle-driven reasoning. This taxonomy offers a systematic approach to assessing pedagogical development via reflection.

Globally, reflective practice is acknowledged as crucial for equipping teachers to adapt to varied educational environments and promote significant learning experiences. In the Philippines, where teacher education programs prioritize content mastery and pedagogical proficiency, reflection acts as a conduit between theoretical coursework and practical classroom experiences. By applying the SOLO framework to reflective narratives, teacher educators can gain a deeper understanding of how Pre-service teachers internalize lesson planning procedures and how these reflections influence the development of their professional careers. This study examined the reflective narratives of third-year Pre-service teachers in Science 102 (Teaching Science in the Specialized Field) during the academic year 2025–2026, concentrating on their articulation of lesson planning and instructional decision-making. The study intended to shed light on the function of reflection in teacher preparation and developed methods for encouraging more profound and significant reflective practices in future educators.

Statement of the Problem:

This study sought to investigate the application of learning by third-year students in Science 102 in the contexts of lesson planning and instructional decision-making. Employing the SOLO (Structure of Observed Learning Outcomes) taxonomy as an analytical framework, the study investigated:

1. How do pre-service teachers integrate concepts and skills learned in Science 102 into their lesson planning and instructional choices?
2. What levels of reflective thinking are evident in their narratives, as categorized by the SOLO framework?
3. How do Pre-service teachers' use of Science 102 learning in lesson planning signal progression in their pedagogical competence, as revealed through SOLO-based reflection?
4. Based on the findings, what evidence-based interventions can be proposed?

THEORETICAL FRAMEWORK:

This study is based on three interconnected theoretical frameworks: the Structure of Observed Learning Outcomes (SOLO) taxonomy, Schön's Reflective Practice Theory, and Constructivist Learning Theory. Collectively, these frameworks offer an extensive perspective for examining the intricacies of Pre-service teachers' reflective narratives in Science 102 and comprehending their pedagogical development.

The SOLO taxonomy, developed by Biggs and Collis in 1982, functions as a fundamental analytical framework for classifying the cognitive complexity of students' reflections. It outlines five sequential levels of comprehension—prestructural, unistructural, multistructural, relational, and extended abstract, enabling educators to evaluate the progression of learners from disjointed knowledge to cohesive and generalized reasoning. SOLO levels differentiate between surface and deep thinking, and one purpose of employing this approach is to assist instructors in guiding students towards enhancing the depth of their thinking (Hunt, Walton, Martin, Haigh, & Irving, 2018). This study will utilize the Structure of Observed Learning Outcome (SOLO) taxonomy to categorize the competence of Pre-service teachers' reflections on lesson planning and instructional decisions.

Schön's Reflective Practice Theory (1983) establishes a conceptual framework for comprehending the processes of reflection-in-action and reflection-on-action among educators. Schön asserted that professional development occurs when practitioners critically reflect on their experiences, question underlying assumptions, and modify their methods either in the moment or retrospectively. His theory continues to exert significant influence in teacher education, especially in fostering reflective practices that connect theoretical concepts with practical application. According to Machost and Stains (2023), Schön's critique of technical rationality and his advocacy for experiential learning persist in influencing reflective pedagogies across various educational contexts. This framework directs the investigation into how Pre-service teachers express their instructional reasoning and address pedagogical challenges.

Finally, Constructivist Learning Theory, based on the theories of Piaget and Vygotsky, provides a comprehensive framework for understanding the role of reflection in pedagogical development. Constructivism asserts that learners actively build knowledge through experience, conversation, and contextual involvement. Within teacher education, reflection serves as a means to reorganize existing knowledge, assimilate new ideas, and develop professional growth. This theoretical framework corroborates the study's premise that higher orders of reflection, specifically those classified as relational and extended abstract, indicate significant pedagogical development and preparedness for classroom application.

By synthesizing these three frameworks, the study sought to systematically analyze the reflective narratives of third-year pre-service teachers in Science 102 (Teaching Science in the Specialized Field), determine their levels of cognitive competence, and

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interpret how these reflections influence their developing instructional proficiency. This approach also enabled the identification of how pre-service teachers progress from simple descriptions of experiences to more meaningful reflection, particularly in connecting and applying concepts within their lesson planning and teaching practices

Significance of the Study

This study is significant to several groups of stakeholders:

For Pre-service students, the study provides an opportunity to determine how their learning in Science 102 can be effectively applied to lesson planning and instructional decision-making. By contemplating their experiences, students can enhance their comprehension of how subject knowledge is applied within pedagogical practice, thereby reinforcing both their reflective abilities and their professional preparedness.

For educators, the findings provide a framework for evaluating the extent of Pre-service teachers' reflective thinking through the application of the SOLO taxonomy. This can function as a reference for the development of instructional strategies, mentoring methods, and assessment tools that promote advanced levels of reflection and more effective application of subject knowledge within classroom settings.

For curriculum implementers and educational administrators, the study emphasizes the significance of incorporating reflective practice into science education programs. Insights derived from the analysis can guide curriculum enhancements, ensuring that subject knowledge is not only preserved but also translated into pedagogical skills that enhance instructional quality and student learning outcomes.

For future researchers, this work establishes a foundational basis for further research into reflective practice within teacher education. It facilitates the exploration of how discipline-specific learning in various fields can be utilized in instructional decision-making and examined through frameworks such as SOLO taxonomy, thereby advancing the wider discourse on teacher development and professional advancement.

Scope, Delimitation and Limitation of the Study

This study focused on third-year science major pre-service teachers at the College of Teacher Education of Pamantasan ng Lungsod ng San Pablo enrolled in Science 102 during the Academic Year 2025–2026. Using total population sampling, data were collected through a validated open-ended questionnaire to gather reflective responses. These were analyzed using the SOLO taxonomy to assess cognitive competence and pedagogical development, particularly in lesson planning and instructional decision-making.

The study was limited to science majors and did not include other year levels or specializations. Findings were based on self-reported reflections and were not generalized to other groups or institutions. Despite these limitations, the study provided valuable insights for improving institutional practices and guiding future research in teacher education.

Definition of Terms

To provide clarity and avoid ambiguity, the following terms are operationally defined as they are used in this study:

Instructional Decisions. This pertains to the choices made by pre-service teachers in organizing, sequencing, and adapting Science 102 content for teaching purposes, as reflected in their narratives.

Lesson Planning. This refers to the process by which pre-service teachers design instructional activities and strategies, specifically integrating concepts learned from Science 102.

Pedagogical Growth. This refers to the progression of pre-service teachers' competence in applying science content knowledge to teaching practice, as revealed through SOLO-based analysis of their reflections.

Pre-service Teachers (Science Majors). This pertains to all third-year students enrolled in the College of Teacher Education, majoring in Science, who will participate in the study. They are the respondents whose reflective narratives will be analyzed.

Reflective Narratives. These are the electronically submitted responses of participants elicited through the validated open-ended questionnaire. The narratives capture how students apply Science 102 learning in lesson planning and instructional decisions.

Science 102 (Teaching Science in the Specialized Field). a core course for third-year Science majors at Pamantasan ng Lungsod ng San Pablo (AY 2025–2026), developed both content knowledge and pedagogical competence. It engaged pre-service teachers in lesson planning, instructional decisions, and reflective practice, integrating theory with classroom application. In this study, reflective narratives from Science 102 were analyzed through the SOLO taxonomy to assess cognitive depth and pedagogical growth.

SOLO Taxonomy (Structure of Observed Learning Outcomes). This is the analytic framework used in the study to categorize the depth of reflective thinking in participants' responses. The taxonomy includes four levels: Unistructural, Multistructural, Relational, and Extended Abstract.

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LITERATURE REVIEW

The literature review includes both theoretical and empirical works pertinent to the research at hand. This section conducts an analysis of the pertinent theories, studies, and current knowledge to offer a comprehensive overview of the subject matter that is the focus of the study.

Science 102 (Teaching Science in the Specialized Field)

The Bachelor of Science in Education (BSED) with a major in Science is a four-year degree aimed at preparing students for jobs as secondary science educators. The program is to develop proficient individuals ready to contribute to the educational and research sectors in the realm of science (Taguig City University, 2025).

In accordance with CHED Memorandum Order 75, 2017, it addresses the objectives, resources, curriculum, evaluation, administration, and pedagogical approaches for teaching science at the secondary level, while also offering opportunities for classroom observation and demonstration teaching.

The "Teaching of Science" necessitates specialized skills, and with ongoing advancements and recent research, the pedagogical approach demands adaptation. Science education is a systematic process that entails providing learners with guidance aimed at facilitating the acquisition of scientific knowledge and process skills, as outlined by Sakthivel and Malathi (2020).

The concept of teaching, as articulated by Grace Mission College (2023), encompasses a range of interpretations that inherently vary among individuals. It can be characterized in several ways based on the essential educational objective deemed worthy of pursuit.

Science teacher education programs are essential in developing future educators. The attitudes of Pre-service Teachers (PSTs) toward science and their self-efficacy beliefs are crucial in influencing their engagement with and the benefits derived from their academic preparation, as described by Ribeirinha and Correia (2025).

As pointed out by Adu-Gyamfi (2020), effective science teaching is not contingent upon instructors' content understanding but rather on their pedagogical approaches. The teachers' proficiency in delivering science content is the paramount criterion to consider in effective science instruction. Educators must possess expertise and understanding of scientific concepts, referred to as strong scientific subject knowledge. Teachers possessing solid content understanding are more inclined to assist students in comprehending scientific concepts.

This circumstance justifies the integration of specialized scientific courses (SSCs) in teacher education curricula. SSCs are science content courses tailored for Pre-Service Teachers, wherein instructors exemplify reform-oriented pedagogy of science subjects corresponding to the grade levels that Pre-Service Teachers would educate, as detailed by Jensen (2018).

Teacher education programs serve as a crucial foundation for cultivating science teachers' pedagogical content knowledge (PCK). To tackle these issues, scholars and policymakers advocate for a transformation in teacher education programs, emphasizing teaching practices above theoretical knowledge of pedagogy. These programs emphasize the cultivation of pedagogical experts rather than subject specialists, as suggested by Saeleset and Friedrichsen (2022).

Mafugu (2022) asserted that science Pre-service teachers are anticipated to apply the theoretical information gained from the several courses within the teacher preparation program during the developmental process. Students must acquire diverse scientific practical skills to differentiate instruction, handle disruptive behavior, prepare peers for advanced cognitive tasks, and contemplate the effects of their pedagogical methods on student development.

In addition, Cepni, Ulger, and Ormanci (2017) saw lesson plans as a component that enhances effective science instruction, emphasizing that well-structured sessions necessitate active student engagement. An effective science pedagogy encompasses (a) course design involving planning and instructional tactics, (b) allocation of responsibilities and resources, (c) implementation techniques related to pace, (d) classroom management, (e) teacher questioning and self-assurance, and (f) classroom culture.

Pre-Service Teachers acquire scientific knowledge by participating in educational discourse. These courses are predicated on the premise that educators typically instruct in manners reflective of their own educational experiences, as posited by (Chan & Hume, 2019).

Lesson Planning and Instructional decision-making

While students pursue a degree in Education, there will consistently be pre-service instructors requiring instruction on the logical organization of teaching and learning processes. Effective mentors are consistently adept planners and critical thinkers. Achieving success necessitates dedication and effort, particularly in skills related to lesson planning and classroom behavior management. Lesson planning is an essential competency that all educators must cultivate, as asserted by Ferrer J. C. (2021).

The knowledge and skills of pre-service teachers regarding the planning and implementation of the teaching-learning process reflect the institution they attended and the educators who imparted their expertise, as elucidated by Emiliyasi (2019).

Teacher preparation is a crucial element in cultivating effective future educators (Yacap, 2022). Several studies aimed to ascertain

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the lesson preparation methods of pre-service teachers at a Teacher Education Institution in the Philippines and to describe their experiences in practical teaching, specifically with lesson planning and preparation.

Lesson planning constitutes a fundamental responsibility of educators regarding instruction. An effective plan necessitates an understanding of the course topic, pedagogy, setting, and learners' background (Marquez & Marquez, 2023).

Lesson planning is a multifaceted endeavor. The correlation between the quality of a lesson plan and an effective teaching-learning process is well recognized by researchers and educators. Consequently, cultivating Pre-service teachers' skills in planning is seen essential for producing competent educators, as evidenced by Sahin-Taskin (2017).

As stated by Farhang, Hashemi, and Ghorianfar (2023), the lesson plan constitutes the foundation of education. The lesson plan constitutes the educational framework and is integral to the learning process. The planning and objectives of a lesson, articulated by the instructor at the outset of the session, constitute one of the most vital and impactful elements in the students' learning process.

Furthermore, a lesson plan serves as the instructor's blueprint outlining the necessary learning objectives and the effective methods for achieving them throughout class time, as highlighted by Dussault (2019). Subsequently, you can formulate suitable educational activities and devise methods to acquire feedback on student comprehension. A lesson plan offers a comprehensive framework of your pedagogical aims, educational objectives, and strategies for achieving them, while it is not exhaustive.

Similarly, Ferrer (2021) asserted that lesson planning commences with the formulation of objectives. It is essential that these objectives conform to the "SMART" criteria and are relevant to the subject matter. Furthermore, the selection of materials for executing the plan is crucial.

The lesson plan is a written document that includes procedures, materials, evaluation techniques, and the time and location for instruction. A lesson plan is defined as a systematic documentation of a teacher's intentions for the content to be addressed in a session or as a series of interconnected lessons centered on a specific theme, as specified by Dussault (2019).

Educators, as delineated by Krepf and Konig (2023), are obligated to meticulously design their instructional activities to initiate and proficiently facilitate their students' learning processes. In lesson planning, educators must foresee the organizational dynamics of instruction, tailor the learning tempo to student requirements, and facilitate seamless transitions between instructional activities. These specific requirements are designated as lesson structuring, given that structuring constitutes a fundamental element of efficacious instruction.

Furthermore, planning enables pre-service teachers to think through what they teach, how they teach, and how to evaluate their teaching (Ruys, Keer & Aelterman; 2012). However, student teachers lack experience in planning and organizing teaching activities

Making the transition from student to pre-service teacher and ultimately to an effective teacher is a formidable challenge in the field of education. Pre-service teachers recognized the need of lesson planning; nonetheless, they encountered challenges during the planning process (Alanazi, 2019).

Pre-service teachers receive training in lesson planning during their education. The literature indicates that pre-service teachers have challenges in lesson planning (Setyono, 2018). The literature highlights that beginner teachers allocate more time to lesson planning and perceive it as a demanding task. Napanoy, Gayagay, and Tuazo (2021) also suggested that pre-service teachers perceived the initial lesson planning steps as 'cumbersome.'

Nonetheless, despite the university's diligent efforts, the pre-service teachers continue to feel inadequately prepared for the more challenging phase of their training—Pre-service teaching—and are unable to fulfill their assigned tasks (Ponce, 2024).

Sural and Dede Bali (2019) argued that pre-service teachers generally perceive themselves as competent in the theoretical components of lesson planning. Although pre-service teachers can theoretically design a lesson plan, when necessary, they may struggle to effectively execute it in practical teaching situations.

SOLO Framework

SOLO, an acronym for Structure of the Observed Learning Outcome, was originally introduced in Evaluating the Quality of Learning: The SOLO Taxonomy outlines the cognitive progression of individuals and is derived from Jean Piaget's theory of children's cognitive development, as described by Li, Wang, and Ma (2021). SOLO is underpinned by a nature-assessing technique distinguished by grade descriptions. The SOLO taxonomy, while intended to classify learning outcomes, does not designate these outcomes as correct or incorrect. The learning outcome is perceived as layers extending from the known to the unknown, and from the simple to the complex; the relationships within these layers are characterized by element to system and part to whole.

SOLO is a methodological tool created by John Biggs and Kevin Collis in 1982, utilized to delineate the escalating complexity of a student's comprehension of a job. It classifies student responses according to the degree of comprehension exhibited, from basic to advanced. It is employed in various educational contexts to evaluate and direct the advancement of student cognition and

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understanding (Caridade, 2024).

In contrast to Bloom's Taxonomy, SOLO prioritizes observable outcomes, allowing educators to structure assignments from superficial comprehension to profound, conceptual analysis. A recent study by Haksoy (2021) underscores its significance in harmonizing curriculum design, instruction, and reading outcomes, especially in language education, as referenced by Caridade and Pereira (2024).

This taxonomy proposes five SOLO levels, including pre-structural, when pupils demonstrate a deficiency in comprehension, frequently overlooking the main concept. The uni-structural level occurs when a student can identify individual aspects of knowledge, with understanding confined to isolated disciplinary information; the multi-structural level is characterized by the learner's ability to accumulate multiple pieces of information, albeit with difficulty in establishing coherent relationships; the relational level is where the student starts to integrate the multi-structural elements into a cohesive whole; and the extended abstract level is reached when students not only connect facts but also extrapolate and hypothesize beyond the provided context, as outlined by (Velasco, 2025).

The SOLO model delineates students' replies through five hierarchical stages of escalating complexity. The levels consist of pre-structural, uni-structural, multi-structural, relational, and extended abstract. The SOLO modes present a sequential abstraction of students' responses, while the SOLO levels elucidate the hierarchical complexity inherent in the structure of those responses. Nonetheless, this does not suggest that the SOLO model typically adheres to a linear trajectory; it frequently culminates in cyclical and spiral cycles, as the levels are reiterated within each mode of functioning, as articulated by (Kaharuddin & Hajeniati, 2020).

The stages progress from "pre-structural," indicating minimal comprehension, to "extended abstract," where students can apply knowledge in novel circumstances, as specified by Clavacio and Legaspi-Estoque (2025).

The Structure of Observed Learning Outcomes (SOLO) taxonomy is a notable framework for organizing learning events and assessing the cognitive development of students (Quinn, 2020).

Effective teaching practices can substantially improve students' cognitive learning, equipping them for academic achievement and future professional settings. Consequently, lesson planning is crucial for the organized presentation of curriculum material. It enables educators to structure educational activities, resources, and time management to enhance student engagement and learning. Moreover, meticulously organized lesson plans improve teacher readiness, enabling educators to foresee obstacles and adapt to varied student requirements (Johnson, 2019).

Cognitive learning is a metacognitive process comprising skills and attitudes that enhance the likelihood of deriving a logical solution to a problem or a valid conclusion to an argument (Quinn, 2020).

The implementation of HOTS and SOLO in education equips instructors and students to develop analytical and adaptive persons for the future. The Department of Education should offer training to educators concerning higher-order thinking abilities and the Structure of Observed Learning Outcomes (SOLO) framework to enhance comprehension and application in their particular disciplines, as proposed by Torres (2024).

The SOLO taxonomy can be utilized to assess students' cognitive processes in learning based on their level of thinking (Triana, et al., 2023). The quality of students' cognitive answers can be compared to ascending phases in the learning process, aligning with the principles of constructivist learning, wherein students develop their own comprehension, facilitated by teacher guidance throughout the educational experience.

The SOLO model offers a taxonomy for evaluating pupils' cognitive development in both quantitative and qualitative terms. This approach enables teachers to evaluate students' cognitive abilities, encompassing reasoning, learning pace, abstract thinking, and the ability to link ideas, rather than merely assessing their memorization skills, as detailed by Adenij, Baker, and Schmude (2022). SOLO elucidates learning outcomes in a hierarchical manner, making it conducive to improving the quality of educational discourse. It serves as an effective instrument for distributing work throughout the curriculum and engages students in significant learning tasks. It offers optimal resources to attain equilibrium between the cognitive requirements of the challenges and to furnish appropriate procedural guidelines for the completion of activities and tasks, as expressed by Khan, Abbas, and Dilshad (2021).

Furthermore, examining student replies using the SOLO framework enables educators to customize instruction and devise effective tactics to rectify particular misconceptions (Shavers, 2022). Instruments grounded on the SOLO taxonomy yield significant insights into student understanding, allowing educators to deliver prompt interventions or tailored assistance (Dumaraos, 2022)

Proper evaluation can ascertain the true competency levels of learners and provide prompt feedback to learners, educators, and educational administrators, while also offering direction for pedagogical enhancement and regulating instructional design and processes. The SOLO taxonomy, as reported by Khan, Abbas, and Dilshad (2021), is distinguished by its capacity to assess student comprehension and evaluate performance. It can be utilized for the assessment of profound learning.

Furthermore, formative feedback associated with SOLO levels offers more precise and effective guidance than generic remarks.

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This targeted feedback allows learners to identify the depth of their comprehension and the specific cognitive skills they need to develop, whether advancing from the recognition of discrete facts to forming relational connections or enhancing sustained abstract reasoning, as emphasized by Abdullah-Masran (2021).

However, the SOLO taxonomy has not been extensively implemented in schools across numerous countries globally, even after nearly four decades of its existence, as noted by Gagani and Misa (2017).

Pre-Service Teachers

Pre-service teachers must attain extensive knowledge and practical experience prior to entering the professional realm. The experiences of pre-service teachers during field study differ; some encounter opportunities, while others have problems (Comia, et al., 2024).

Practice Teaching necessitates diverse strategies, thorough preparation, and effective classroom management, which can pose significant challenges for inexperienced educators (Antallan, et. al., 2022). For instance, Evans and Gray (2023) discovered that deficiencies in lesson planning and classroom administration skills impeded the learning progress of pre-service teachers during their teaching practicum. Significant difficulties that pre-service teachers encounter during fieldwork include low confidence, inadequate classroom management, and a lack of teamwork, as reported (Aldabbus, 2020).

Many students grappled with reconciling their academic obligations with the necessity of generating revenue, frequently resulting in heightened stress, diminished academic performance, and a scarcity of personal time. Students encountered issues such as difficulties in time management and the potential compromise of academic achievement, as observed by Mendoza and Fernandez (2024).

According to Karahan (2022), traditional science education is outdated, having been criticized for its inadequacy in engaging students with dynamic and open-ended real-world problems characteristic of an ever-evolving, technology-driven world. Therefore, science teachers should be equipped to assist students in addressing the complexities of science as they relate to real-world societal issues.

A study conducted by Ilocos Sur Polytechnic State College indicates that a deficiency in pedagogical knowledge can hinder the capacity to design effective learning experiences, emphasizing the need for substantial training efforts for prospective educators, as reported by (Bustillo, Peligro, & Enaje, 2024).

According to the study 'Problems met in lesson planning by the Pre-service Teachers' conducted by Bustillo, Peligro, and Enaje (2024), one of the common responses when pre-service teachers are asked about their challenges in practical teaching is "developing lesson plans."

Furthermore, the findings of the study indicated that pre-service teachers faced difficulties in lesson planning due to insufficient knowledge and reluctance to engage in lesson planning discussions with their instructors (Napanoy, Gayagay, & Tuazon, 2021).

Additionally, Fakhrunnisa (2021) states that pre-service instructors encounter challenges in designing Lesson Plans, particularly in selecting appropriate learning methods.

Student-teachers, as described by Bustillo, Peligro, and Enaje (2024), are more focused on managing the immediate demands of classroom instruction than on developing effective strategies for resource planning.

Similarly, participants faced challenges in designing lesson plans, especially in formulating clear objectives. Developing a lesson plan is an integral component of the teaching process for pre-service teachers, as it enables them to effectively conduct a class, as reported (Emiliasari, 2019).

Similarly, novice teachers discuss attaining their competency goals through various strategic approaches, and in each of these approaches, the strategies employed by novice teachers are essential to their comprehension of the duties of teacher and student, as pointed out by (Goh, Yusuf, & Won, 2017).

This indicates that teachers are now mandated to execute and align their instructional methods and actions, as outlined in the standards, to attain a high level of teaching proficiency. Nonetheless, the assessment of pre-service teachers based on competency standards continues to be a central aspect of their 'rite of passage' into the teaching profession.

Regrettably, the competency of a pre-service teacher is assessed almost immediately during their teaching periods through observations conducted by their superior as part of their performance evaluation prior to confirmation into the teaching profession, as reported by (Plessis & Razmjoe, 2025).

Synthesis

The reviewed literature consistently underscores the centrality of lesson planning and reflective practice in the professional preparation of pre-service teachers. Several scholars agree that effective lesson planning is a cornerstone of pedagogical competence. For instance, Ferrer (2021), Marquez & Marquez (2023), and Dussault (2019) all emphasize that lesson planning provides a structured framework for teaching, aligning objectives, materials, and strategies to ensure meaningful learning

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experiences. Similarly, Cepni, Ulger, and Ormanci (2017) highlight that well-structured lesson plans foster active student engagement, while Krepf and Konig (2023) stress the importance of meticulous structuring to facilitate seamless instructional transitions. These perspectives converge on the notion that lesson planning is not merely procedural but foundational to effective science pedagogy.

In parallel, scholars such as Adu-Gyamfi (2020) and Saeleset & Friedrichsen (2022) agree that pedagogical approaches, rather than mere content mastery, define effective science teaching. This aligns with Constructivist perspectives (Chan & Hume, 2019), which argue that teachers often replicate their own learning experiences, thereby necessitating reflective practice to transform content knowledge into pedagogical expertise. The literature also converges on the importance of reflective practice as a mechanism for bridging theory and practice. Schön's Reflective Practice Theory (1983), as cited by Machost & Stains (2023), and the SOLO taxonomy (Biggs & Collis, 1982; Li, Wang, & Ma, 2021) are widely acknowledged as frameworks that enable deeper analysis of pre-service teachers' cognitive and pedagogical growth.

However, points of disagreement emerge regarding the extent of pre-service teachers' preparedness and competence in lesson planning. While Sural and Dedeali (2019) argue that pre-service teachers generally perceive themselves as competent in theoretical aspects of lesson planning, other studies such as Setyono (2018), Napanoy, Gayagay, & Tuazo (2021), and Ponce (2024) reveal that many pre-service teachers struggle with practical implementation, finding lesson planning cumbersome and feeling inadequately prepared for classroom realities. Alanazi (2019) further notes that despite recognizing the importance of lesson planning, pre-service teachers encounter persistent challenges in its execution. This divergence highlights a tension between theoretical confidence and practical application, suggesting that while teacher education programs impart knowledge, they may fall short in equipping students with the skills to translate plans into effective classroom practice.

The literature also presents nuanced perspectives on the role of specialized science courses (Jenset, 2018; Mafugu, 2022). While these courses are seen as essential for developing pedagogical content knowledge and scientific practical skills, some scholars caution that without reflective integration, such courses risk reinforcing technical rationality rather than fostering adaptive, learner-centered teaching. This is where the SOLO taxonomy gains prominence, as it provides a structured lens to differentiate between surface-level reflections and deeper, principle-driven reasoning (Velasco, 2025; Adenij, Baker, & Schmude, 2022). In agreement, Quinn (2020) and Torres (2024) advocate for the integration of higher-order thinking skills with SOLO to enhance cognitive development and instructional decision-making.

METHODOLOGY

This chapter deals with the research methods used in the study. It includes discussion on research design, respondents of the study, sampling design, data gathering instrument, data gathering procedure, and statistical treatment of data

Research Design

The study utilized a qualitative-descriptive design to investigate how third-year pre-service teachers in Science 102 implemented their learning in lesson planning and instructional decision-making. The qualitative-descriptive design, as articulated by Creswell (2018), was employed to collect and analyze participants' experiences, reflective narratives, and meaning-making processes within genuine situations. This research design proved advantageous as it facilitated a systematic examination of pre-service teachers' reflective thinking through the SOLO taxonomy, offering insights into their pedagogical growth and professional development paths.

Respondents of the Study

The targeted respondents for this study were third-year pre-service teachers enrolled in Science 102 at the College of Teacher Education, Dalubhasaan ng Lungsod ng San Pablo. A total of 13 respondents, all of whom were Science majors, were involved throughout the school year 2025–2026. The table below demonstrated the distribution of respondents engaged in the data collection process, focusing on their reflective narratives, lesson planning outputs, and instructional decision-making as examined through the SOLO taxonomy framework.

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Table 1: Distribution of the Respondents of the Study

Year Level	Male	Female
Third Year	4 (31%)	9 (69%)

Sampling Technique

The research employed total enumeration in selecting its respondents. Total enumeration was a purposive sampling technique in which the researcher included the entire population that met specific characteristics. This study examined all 13 third-year pre-service teachers enrolled in Science 102 (Teaching Science in the Specialized Field) at the College of Teacher Education, Major in Science, Dalubhasaan ng Lungsod ng San Pablo. With a relatively small population, the application of this technique enabled accurate assessment and improved the significance of the findings from the study.

Research Locale

The research was conducted in the College of Teacher Education of Dalubhasaan ng Lungsod ng San Pablo in San Pablo City, Laguna, Philippines. The institution functioned as the principal training facility for future educators within the community, providing specialized programs in teacher education, including Science Education. The locale was especially appropriate for this research as it granted access to third-year pre-service educators enrolled in Science 102, who constituted the primary participants of the study.

The College of Teacher Education promoted both theoretical and practical training for educators, providing an optimal environment to investigate how pre-service teachers implemented their Science 102 knowledge in lesson planning and instructional decision-making. The academic atmosphere fostered reflective practice and professional development, aligning with the study's emphasis on examining pre-service teachers' narratives using the SOLO taxonomy framework.

Figure 1: Dalubhasaan ng Lungsod ng San Pablo



Research Instrument

The research aimed to examine how third-year pre-service teachers in Science 102 applied their learning to instructional decision-making, with particular attention to their reflective narratives. To gather the necessary data, the researcher utilized a researcher-made reflective narrative guide structured around the SOLO (Structure of Observed Learning Outcomes) taxonomy. The reflective narrative guide was specifically developed by the researcher to align with the objectives of the study. It consisted of structured prompts and guiding questions designed to evaluate three constructs: (1) integration of Science 102 concepts into instructional decisions, (2) articulation of reasoning behind pedagogical choices, and (3) levels of reflective thinking. The

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instrument included open-ended narrative items and scenario-based prompts, allowing pre-service teachers to express their thought processes and connect Science 102 learning to classroom practice. Responses were analyzed and categorized according to the SOLO taxonomy levels, ranging from unistructural to extended abstract.

To ensure validity and reliability, the researcher-made instrument underwent expert validation by educators specializing in science education. A pilot test was conducted with a comparable group of fourth-year pre-service teachers to refine the clarity, alignment, and applicability of the prompts.

The use of reflective narratives as the primary instrument generated rich qualitative data that was systematically analyzed through the SOLO taxonomy framework to assess pre-service teachers' pedagogical growth and professional development trajectories.

Data Gathering Procedures

This study was designed to examine how third-year pre-service teachers in Science 102 at Dalubhasaan ng Lungsod ng San Pablo applied their learning to instructional decision-making, with particular attention to their reflective narratives. Prior to their participation, respondents received an Informed Consent Form (see Appendix B) that outlined the study's objectives, procedures, and measures to ensure confidentiality. Additionally, a formal letter (see Appendix C) was provided to encourage voluntary participation and emphasize the importance of their contributions to the research.

The researcher-made reflective narrative guide (refer to Appendix A) was administered to the pre-service teachers through Google Forms. This instrument was structured around the SOLO (Structure of Observed Learning Outcomes) taxonomy and consisted of prompts designed to capture the integration of Science 102 concepts, instructional decision-making processes, and varying levels of reflective thinking. Responses were collected in narrative form, allowing participants to articulate their reasoning and pedagogical insights.

Qualitative procedures were employed to conduct a thorough examination of the collected data. The narratives were analyzed using thematic coding and categorized according to SOLO taxonomy levels, ranging from unistructural to extended abstract. This structured analysis provided insights into the reflective depth and pedagogical growth of pre-service teachers. By integrating these components, the study established a comprehensive understanding of how Science 102 learning contributed to instructional decision-making and professional development advancements.

The collection of data through Google Forms ensured efficiency, accessibility, and ease of participation for all respondents. The research upheld impartiality and relied on empirical evidence, avoiding unnecessary or subjective interpretations, thereby ensuring the validity and reliability of the findings.

Statistical Treatment of Data

After all the data were gathered, they were organized, coded, analyzed, and interpreted according to the categories of the SOLO (Structure of Observed Learning Outcomes) taxonomy. The qualitative analysis focused on identifying the depth of reflective thinking evident in the pre-service teachers' narratives and instructional decision-making. To ensure systematic interpretation, the following analytic procedures were employed:

Frequency and Percentage. This tool was used to determine the frequency of responses across the different SOLO taxonomy levels (uni-structural, multi-structural, relational, and extended abstract). The analysis provided an overview of how pre-service teachers' reflections were distributed across levels of complexity, offering insights into their pedagogical growth.

Mean. The mean was computed to determine the average level of reflective thinking demonstrated by the respondents. This measure of central tendency provided a general picture of the depth of reflection among pre-service teachers when applying Science 102 learning to instructional decision-making.

Standard Deviation. This was calculated to evaluate the variability of responses across SOLO taxonomy levels. It provided information on the degree of consistency or divergence in the reflective narratives, indicating whether pre-service teachers demonstrated similar or varied levels of reflective thinking.

Thematic Coding and SOLO Categorization. Beyond descriptive statistics, qualitative coding was applied to the narratives to identify recurring themes and patterns. These coded responses were then categorized according to SOLO taxonomy levels, allowing for a structured analysis of reflective depth and pedagogical insights.

By integrating descriptive statistics with qualitative coding, the study established a comprehensive understanding of how Science 102 learning was applied in lesson planning and instructional decision-making. This dual approach ensured both measurable distribution of reflective levels and rich interpretation of the narratives, thereby capturing pre-service teachers' pedagogical growth and professional development paths.

Ethical Considerations in Research

The ethical considerations of this study focused on safeguarding data privacy and ensuring that informed consent was obtained from all participants. Compliance with data privacy laws and institutional regulations protected the personal information of pre-

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service teachers. Authorization for the study was granted by the Data Privacy Officer, with approval from the Dean of the College of Teacher Education.

Participants, specifically third-year pre-service teachers enrolled in Science 102, were provided with an informed consent form (see Appendix B) outlining the study's objectives, procedures, benefits, and confidentiality measures. They were encouraged to ask questions before voluntarily participating.

Data were collected through a researcher-made reflective narrative guide administered via Google Forms for accessibility. All responses were kept confidential, securely stored, and used solely for academic purposes. The study upheld ethical principles such as autonomy, privacy, and confidentiality, ensuring respect for the dignity and welfare of all participants

PRESENTATION, ANALYSIS, RESULTS, AND DISCUSSION

This chapter presents the findings of the study, together with their analysis and interpretation as derived from the collected data. The results are discussed in relation to the research objectives, providing insights into their significance and implications.

Science 102 Integration in Lesson Planning

Many participants emphasized inquiry-based learning as a central guiding principle in their instructional choices. One participant reflected, "One of the most significant influences was the emphasis on inquiry-based learning," underscoring a deliberate shift away from rote memorization toward active exploration. Another elaborated, "I chose a discovery-based experiment rather than a traditional lecture. I am more of activities and actual application of concepts." These reflections illustrate how Science 102 encouraged pre-service teachers to design lessons that position students as active constructors of knowledge rather than passive recipients.

This orientation toward inquiry signals a pedagogical transformation: teachers are not merely transmitting information but are cultivating environments where learners engage in investigation, experimentation, and problem-solving. Such practices resonate with (Jong, et al., 2023), who argue that inquiry-based approaches foster deeper conceptual understanding and enhance students' ability to apply knowledge in novel contexts. By embedding inquiry into lesson planning, pre-service teachers demonstrate an emerging competence in aligning instructional strategies with contemporary science education frameworks that prioritize critical thinking and authentic engagement.

Moreover, the emphasis on discovery-based activities reflects a broader commitment to learner-centered pedagogy. It suggests that Science 102 provided not only theoretical grounding but also practical models that empowered future educators to reimagine classroom dynamics. In this way, inquiry-based learning becomes both a methodological choice and a philosophical stance—one that positions students at the heart of the learning process while simultaneously strengthening teachers' reflective practice and professional growth.

Pre-service teachers consistently connected Science 102 to improvements in lesson planning and instructional decision-making. One participant reflected, "The lesson planning and the curriculum of science, it helps me to enhance my decision making in facilitating the class and foster to create more instructional materials, that will engage the classroom discussion." Another added, "The specific Science 102 ideas that influenced my instructional decisions are anything related to making DLP and the teaching demo proper." These reflections underscore how Science 102 provided a structured framework for aligning instructional materials with objectives, thereby enhancing classroom flow and coherence. This finding is supported by (Khan, et al., 2025) principle of constructive alignment, which emphasizes the importance of coherence between objectives, teaching strategies, and assessment in fostering meaningful learning experiences.

Another significant theme was improvisation and resourcefulness, particularly in contexts where material resources were limited. One participant explained, "By using it as a guide and idea, for example in every experiment, not all the equipment you need can be provided by the school and by that you'll think of a way to replace them." Another echoed, "For me, improvisation of instructional materials made a big impact on how I handle and influence my instructional decision." These accounts highlight how Science 102 nurtured adaptability, encouraging teachers to creatively substitute or design instructional materials to sustain inquiry-based learning. (Akpan & James, 2026) affirms that improvisation fosters creativity and contextualized teaching, particularly in science classrooms where resource constraints are common. Thus, resourcefulness becomes not merely a survival strategy but a pedagogical skill that enhances engagement and contextual relevance.

Equally prominent was the theme of learner-centered and inclusive approaches, reflecting responsiveness to student diversity. One participant shared, "Learner-centered and inclusive teaching principles from Science 102 influenced my instructional decisions, along the emphasis on adaptability and reflective practice." Another elaborated, "In selecting a particular teaching method for my lesson it should always align with the level of the students and also their learning styles... most of the time I'm using a student-centered method because it helps my students to better understand what I am teaching." These reflections reveal how Science 102 instilled inclusive pedagogical principles, ensuring that instructional strategies were tailored to varied learning styles and abilities.

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This aligns with (Jardinez & Natividad, 2024), who argue that inclusive teaching requires adaptability and recognition of diverse learner needs. The participants’ emphasis on inclusivity demonstrates a growing awareness of equity in science education, positioning them to design lessons that are both accessible and engaging.

A recurring theme was reflective practice, which emerged as a cornerstone of professional growth. One teacher explained, “I learned beyond measure in Science 102, particularly in understanding the realities that teachers face in the actual classroom setting... Concepts such as learner-centered instruction, inquiry-based learning, and constructive alignment strongly influenced how I designed my lessons, selected teaching strategies, and structured assessments.” Another added, “It allows me to change, develop, and make improvements for my next teaching strategies.” These statements illustrate how Science 102 cultivated reflective habits, enabling teachers to critically evaluate and refine their approaches. (Diseth, 2025) emphasizes reflection-in-action as essential for professional growth, and the participants’ narratives resonate strongly with this framework, showing how reflection guided continuous improvement in instructional design.

Finally, assessment alignment was highlighted as a crucial outcome of Science 102. One participant stated, “Curriculum evaluation through learning assessment has influenced my instructional decisions.” Another explained, “These concepts and ideas... teach me to create more scientific and inclusive assessment that will help students to foster their learning specifically in problem-solving and to encourage diverse students to participate in class assessments.” These reflections show how Science 102 guided them to design assessments beyond recall, focusing instead on inclusivity, problem-solving, and authentic engagement. This is consistent with current calls for performance-based and formative assessments in science education (Levy-Feldman, 2025), which emphasize the role of assessment in promoting deeper learning and equity.

Reflective Thinking in Pre-Service Teachers (SOLO)

As shown in Table 1, the distribution of responses across the SOLO levels indicates that a substantial proportion of participants’ reflections are categorized under the unistructural level (48.9%), suggesting that most responses remain at a surface level. This implies that participants tend to focus on single, isolated aspects of their teaching experience, reflecting a fragmented understanding of instructional concepts.

Nevertheless, Table 1 also reveals that 25.0% of the responses fall under the relational level, indicating that a notable group of participants demonstrates the ability to integrate multiple teaching elements (e.g., strategies, assessment, and learner needs) into a coherent understanding. This finding suggests the presence of emerging reflective competence, where participants begin to connect theory and practice meaningfully.

In contrast, the extended abstract level accounts for only 6.5% of the total responses, as shown in Table 1, highlighting that only a limited number of participants engage in higher-order, transformative reflection. At this level, reflections extend beyond

immediate classroom experiences toward generalization, critical evaluation, and the development of a theory-informed teaching perspective.

Table 2:
Frequency of Responses Across SOLO levels

SOLO Level	Frequency (f)	Percentage (%)
Prestructural	0	0
Unistructural	45	48.9
Multistructural	21	22.8
Relational	23	25.0
Extended Abstract	6	6.5
Total	92	100

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The majority of responses fall under the unistructural level, indicating limited reflection where participants focus on a single aspect of teaching without elaboration or connection to broader concepts. Typical responses are descriptive and isolated:

"For me, improvisation of instructional materials made a big impact on how I handle and influence my instructional decision." (Participant 3)

"The specific Science 102 ideas influenced my instructional decisions is EVALUATING." (Participant 9)

"I lack the time to prepare for my demo teaching." (Participant 11)

These statements demonstrate minimal reflection, often identifying only one factor (e.g., materials, evaluation, time constraint) without explaining relationships or implications.

Responses classified as multistructural show multiple relevant ideas, but these remain unconnected or loosely related. Examples include:

"The lesson planning and the curriculum of science... create more instructional materials... facilitate and make plans..." (Participant 2)

"It makes me a person who will thoroughly check if the strategies will suit the learner... if my materials serve its purpose..." (Participant 4)

Although participants mention several teaching components (planning, materials, assessment), they do not clearly synthesize these into a coherent framework of instructional decision-making.

At the relational level, participants demonstrate integrated understanding, connecting multiple aspects of teaching and reflecting on their interplay. Illustrative responses include:

"Concepts such as learner-centered instruction, inquiry-based learning, and constructive alignment strongly influenced how I designed my lessons... ensuring that each activity... aligned with intended learning outcomes." (Participant 7)

"I intentionally incorporated hands-on activities... to move students from surface-level understanding to deeper conceptual connections." (Participant 8)

These narratives exhibit coherence, linking strategies, assessment, and learning outcomes, reflecting a deeper level of pedagogical thinking.

Only a small proportion of responses reached the extended abstract level, characterized by generalization, transfer, and critical reflection beyond the immediate context. Examples:

"Learning Science 102 feels like a turning point... I started asking others for their suggestions... it is not just me inside the classroom." (Participant 6)

"I now view challenges... not as failures, but as opportunities to refine my strategies and deepen my understanding... becoming an adaptive science educator." (Participant 8)

These responses demonstrate metacognitive awareness, professional growth, and the ability to transfer learning into broader teaching philosophy and future practice.

The analysis indicates that while participants demonstrate awareness of key Science 102 concepts, their reflective thinking is predominantly introductory to developing, with limited abstraction.

SOLO-Based Progression in Pedagogical Competence

At the unistructural level, teachers begin to demonstrate an initial awareness of pedagogical implications derived from their engagement with Science 102. At this stage, reflection is limited to a singular aspect of teaching practice, indicating emerging but still constrained professional insight. For example, a teacher might state, "I realized I should prepare better demonstrations for my students." Such a response reflects a developing competence; however, the reflection remains narrowly focused on one element of instructional delivery, rather than encompassing the broader dynamics of the teaching-learning process.

Progressing to the multistructural level, teachers exhibit an increased capacity to identify multiple pedagogical applications of their Science 102 learning. These may include incorporating inquiry-based approaches, utilizing diverse assessment strategies, and improving classroom management techniques. A representative reflection might be: "I need to manage time better, ask guiding questions, and prepare visual aids." While this level indicates growing pedagogical awareness and competence, the identified strategies remain discrete and fragmented. There is limited evidence of integration, as the teacher has yet to synthesize these elements into a cohesive instructional framework.

At the relational level, teachers demonstrate a more advanced and integrated form of pedagogical competence. Reflection at this stage involves recognizing the interconnections among various teaching strategies and understanding how these elements collectively influence instructional effectiveness. For instance, a teacher may reflect: "Poor time management affected my ability to ask questions and use visual aids effectively. By organizing my schedule, I can connect these strategies to improve student engagement." This level signifies a deeper conceptual understanding, wherein teaching is viewed as a dynamic and interconnected system. Such reflective practice highlights the teacher's ability to analyze and refine their approach in a holistic

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manner.

Finally, at the extended abstract level, teachers transcend immediate classroom concerns and demonstrate the ability to generalize their Science 102 learning into broader educational principles. Reflection at this level reveals advanced pedagogical competence, characterized by abstraction, transferability, and alignment with professional standards. For example, a teacher may articulate: "This experience taught me that effective science teaching requires fostering metacognitive skills and inquiry-based learning. I can apply these principles not only in my lessons but also in curriculum design." This indicates a capacity to extend insights beyond specific teaching contexts, thereby contributing to ongoing professional growth and the development of more sophisticated educational practices.

Evidence-Based Interventions

Based on the findings of the study, particularly the predominance of pre-service teachers' reflections at the Unistructural and Multistructural levels, as well as the gradual progression of pedagogical competence when connections are made across concepts,

several evidence-based interventions are proposed. These interventions are grounded in established research on reflective practice and metacognitive development, and are intended to systematically support the advancement of higher-order thinking in teacher education.

Intervention 1: Scaffolded Reflective Practice

The results revealed that a considerable number of participants demonstrated limited reflective depth, often characterized by isolated observations or narrowly focused insights. Such patterns are indicative of Unistructural and Multistructural levels within the SOLO taxonomy, where understanding remains fragmented and lacks integration. To address this gap, the implementation of scaffolded reflective practice is recommended.

This intervention involves the structured use of reflective tools such as guided journals, sequenced prompts, and rubrics explicitly aligned with SOLO taxonomy levels. For instance, prompts may initially encourage identification of singular teaching experiences (Unistructural), then gradually require comparison of multiple ideas (Multistructural), synthesis of relationships (Relational), and eventually generalization to broader pedagogical theories (Extended Abstract). Through this progression, learners are systematically guided from surface-level reflection toward deeper analytical and conceptual engagement.

The rationale for this approach lies in its capacity to reduce cognitive overload while simultaneously directing attention to key aspects of reflective thinking. Empirical studies in teacher education have demonstrated that scaffolded reflection enhances the quality of reflective outputs, promoting coherence, criticality, and abstraction.

Furthermore, the use of rubrics provides transparent criteria for progression, enabling pre-service teachers to self-monitor their development and identify areas for improvement.

In effect, scaffolded reflective practice not only supports cognitive structuring but also fosters metacognitive awareness. By making thinking processes explicit, pre-service teachers become more capable of evaluating their instructional decisions, thereby contributing to sustained professional growth.

Intervention 2: Lesson Planning Workshop with SOLO Integration

Another key finding of the study is the observable improvement in pedagogical competence when pre-service teachers are able to relate their learning in Science 102 to broader instructional frameworks. This suggests that meaningful learning occurs when connections are formed, aligning with the Relational and Extended Abstract levels of the SOLO taxonomy. To strengthen this progression, lesson planning workshops that explicitly integrate SOLO principles are proposed.

These workshops would involve guided activities wherein pre-service teachers design lesson plans while concurrently mapping their reflective insights onto SOLO levels. For example, participants may be required to identify whether their lesson objectives merely list content (Multistructural) or demonstrate integrated understanding across concepts (Relational). Additionally, they may be encouraged to extend their plans by proposing adaptations for diverse contexts, thereby reaching the Extended Abstract level.

The integration of SOLO into lesson planning serves as both a diagnostic and developmental tool. It makes cognitive progression visible, allowing pre-service teachers to concretely identify the depth of their understanding and pedagogical reasoning.

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Moreover, this approach promotes intentionality in teaching design, as participants become more aware of how instructional strategies align with desired learning outcomes.

The effectiveness of this intervention is supported by research in curriculum and instructional design, which highlights the role of metacognitive frameworks in enhancing teaching quality. Frameworks such as SOLO provide a structured lens through which educators can evaluate and refine their practice, leading to deeper conceptual understanding and more coherent instructional planning.

Ultimately, these workshops facilitate the integration of theory and practice. By embedding reflective thinking within the lesson planning process, pre-service teachers are better equipped to design instruction that not only transmits knowledge but also fosters higher-order thinking among learners.

The proposed interventions directly respond to the identified needs of the participants by targeting both reflective depth and pedagogical integration. Scaffolded reflective practice addresses the issue of fragmented understanding, while SOLO-integrated lesson planning workshops promote the development of relational and abstract thinking. Both interventions are complementary, as they emphasize structured guidance, metacognitive awareness, and progressive cognitive complexity.

Thus, the implementation of these evidence-based strategies is expected to enhance the overall quality of teacher preparation, enabling pre-service teachers to transition from surface-level reflections to sophisticated, theory-informed, and contextually adaptable pedagogical practices.

Summary

The study shows that pre-service science teachers largely demonstrate surface-level reflective thinking at the Unistructural and Multistructural levels, with limited progression to deeper, integrated understanding. While some improvement is observed when concepts are connected, higher-order thinking remains underdeveloped. These findings highlight the need for scaffolded reflection and the use of frameworks like SOLO to strengthen critical thinking and pedagogical integration in lesson planning.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY OF FINDINGS

This study aimed to examine the level of reflective thinking of pre-service teachers using the Structure of Observed Learning Outcomes (SOLO) taxonomy. It also sought to determine the extent to which respondents demonstrate different levels of understanding and cognitive development in their reflections. Based on the analysis of the collected data, the following key findings were obtained:

- The majority of the respondents demonstrated basic to developing levels of reflective thinking, primarily within the unistructural and multistructural levels of the SOLO taxonomy, indicating surface-level understanding of concepts.
- A smaller proportion of pre-service teachers exhibited relational thinking, showing the ability to connect ideas and apply concepts meaningfully in their reflections.
- Only a few respondents reached the extended abstract level, suggesting that higher-order reflective thinking, such as generalizing and transferring knowledge to new contexts, remains limited.
- Respondents showed strength in identifying and describing learning experiences, but encountered difficulty in analyzing, synthesizing, and critically evaluating those experiences.
- Overall, the findings indicate that while pre-service teachers are capable of reflection, their depth of reflective thinking needs further enhancement, particularly in developing higher-order cognitive skills aligned with the upper levels of the SOLO taxonomy.

CONCLUSIONS

Based on the findings of the study, the following conclusions were drawn:

- Pre-service teachers are able to integrate concepts and skills learned in Science 102 into their lesson planning and instructional choices; however, such integration is generally basic and fragmented. Most respondents focus on incorporating isolated concepts rather than demonstrating a coherent application of scientific knowledge and pedagogical strategies.
- The reflective thinking evident in the narratives of pre-service teachers is predominantly at the unistructural and multistructural levels of the SOLO taxonomy. Only a limited number of respondents demonstrate relational thinking, and very few reach the extended abstract level, indicating that higher-order reflection is not yet fully developed.
- The use of Science 102 learning in lesson planning suggests a gradual but limited progression in pedagogical competence. While some pre-service teachers show improvement by making connections between concepts (relational level), the majority remain at lower levels, reflecting emerging rather than advanced pedagogical understanding.

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- The findings indicate the need for targeted, evidence-based interventions to enhance reflective thinking and pedagogical competence. These include the implementation of structured reflection activities, guided questioning, explicit instruction in higher-order thinking, and continuous feedback mechanisms to support the development of deeper, more meaningful reflection aligned with higher SOLO levels.

RECOMMENDATIONS

In light of the conclusions drawn from this study, the following recommendations are proposed:

- Teacher education programs should integrate structured reflective activities that guide students toward higher levels of thinking, particularly toward the relational and extended abstract levels of the SOLO taxonomy.
- Instructors should provide explicit instruction and modeling of reflective thinking, including examples of deep and critical reflection.
- The use of reflective journals, portfolios, and guided questioning techniques should be strengthened to promote deeper analysis, synthesis, and application of knowledge.
- Pre-service teachers should be encouraged to engage in collaborative reflection, such as peer discussions and feedback sessions, to broaden perspectives and improve critical thinking.
- Future researchers may conduct similar studies using larger samples or different contexts, or explore interventions that effectively improve reflective thinking skills based on the SOLO framework.

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APPENDIX A LETTER TO DEAN

JAY ANN C. OCTOMAN, LPT, PhD

Dean, College of Teacher Education Dear Dr. Octoman,
Greetings!

I am writing to respectfully request your assistance in facilitating the administration of the test for my faculty research study entitled **"EXAMINING PRESERVICE TEACHERS' REFLECTIVE NARRATIVES IN SCIENCE 102: A SOLO TAXONOMY APPROACH TO PEDAGOGICAL GROWTH AND INSTRUCTIONAL DECISION-MAKING"**. As part of

the data-gathering process, I am seeking to administer the research instrument to students from the College of Education, particularly those in Third year majoring in science.

In line with this, I respectfully request permission to administer the reflective narrative questionnaire during my scheduled class period from **4:00–5:30 PM on Monday, January 5, 2026**, as part of the data-gathering process. Utilizing this class hour will allow for the orderly conduct of the activity without disrupting students' regular academic schedules.

Rest assured that all ethical guidelines and data privacy measures will be strictly observed in the conduct of this study. I am also willing to coordinate with instructors to minimize conflicts with class activities.

Thank you very much for your support and consideration. I would be truly grateful for your approval of this request.

Respectfully Yours,

JOHN ROLDAN C. DIMAANO, LPT, MAED

Faculty Researcher Approved by:

JAY ANN C. OCTOMAN, LPT, PhD

Dean, College of Teacher Education

APPENDIX B INFORMED CONSENT FORM

EXAMINING PRESERVICE TEACHERS' REFLECTIVE NARRATIVES IN SCIENCE 102: A SOLO TAXONOMY APPROACH TO PEDAGOGICAL GROWTH AND INSTRUCTIONAL DECISION-MAKING

JOHN ROLDAN C. DIMAANO

johnroldan.dimaano@deped.gov.ph

PART I. Information Sheet INTRODUCTION

I am John Roldan C. Dimaano, a researcher conducting a study under the College of Teacher Education. I would like to invite you to participate in a research study entitled "Examining Preservice Teachers' Reflective Narratives In Science 102: A Solo Taxonomy Approach to Pedagogical Growth and Instructional Decision-Making". This study uses the SOLO Taxonomy framework to analyze how reflective writing demonstrates pedagogical growth and informs instructional decision-making.

PURPOSE OF THE RESEARCH

The purpose of this study is to:

- Explore the depth and quality of preservice teachers' reflective narratives.
- Categorize reflections using the SOLO Taxonomy (from surface to extended abstract levels).
- Identify how reflective practice contributes to instructional decision-making and professional growth.

Your participation will help generate insights into how reflective writing can be used as a tool for teacher education and curriculum development.

TYPE OF RESEARCH INTERVENTION

If you choose to participate in this study, you will first receive an informed consent form detailing the study's objectives, methodologies, and confidentiality measures. You will have the opportunity to ask questions before deciding to participate. Once you provide your consent, you will be asked to:

- Provide reflective narratives based on your experiences in Science 102
- Allow these narratives to be analyzed using the SOLO Taxonomy framework.
- Participate in optional follow-up interviews or discussions to clarify or expand on your reflections

Your participation in this study is entirely voluntary, and all responses will remain confidential. If at any point you feel uncomfortable or wish to withdraw from the study, you may do so without any consequences.

Examining Pre-Service Teachers' Reflective Narratives in Science 102: A Solo Taxonomy Approach to Pedagogical Growth and Instructional Decision-Making

PARTICIPANT SELECTION

You are being invited because you are currently enrolled in Science 102 as a preservice teacher. Your experiences and reflections are valuable in understanding how reflective practice supports pedagogical growth.

VOLUNTARY PARTICIPATION

Your participation in this study is entirely voluntary. You are free to decide whether or not to take part in this research. Withdrawing from the study will not result in any negative consequences, nor will it affect any relationship you may have with the researcher or the institution. If you choose to withdraw before data collection is completed, any data you have provided will be permanently deleted. Additionally, if you wish to review your responses in individual interviews or surveys, you have the right to request changes or remove parts of your input.

PROCEDURES

This research study will consist of an online reflective narrative questionnaire using google forms.

The online survey questionnaire, administered through Google Forms, will gather information about your background, experiences in Science 102, and your initial perspectives on reflective practice. The survey will include straightforward questions designed to understand your familiarity with reflective writing and its role in instructional decision-making. No personal or sensitive information will be required, and your responses will be kept anonymous.

These narratives will be examined using the SOLO Taxonomy framework to assess the depth of your understanding and to identify evidence of pedagogical growth. In some cases, you may be invited to participate in short follow-up discussions to clarify or expand on your reflections. These tasks are designed to evaluate how reflective practice supports instructional decision-making in real classroom contexts.

There are no sensitive or embarrassing questions included in either the survey or the reflective tasks. However, if at any point you feel uncomfortable with any of the questions or activities, you are welcome to ask for clarification or choose not to participate in that section.

DURATION

Participation will occur during the semester in which Science 102 is offered. Data collection will be limited to this period. The total time commitment for this study will be approximately 1 hour and 10 minutes.

RISKS

This study poses minimal risk. You may feel self-conscious when sharing reflections, but there are no right or wrong answers.

BENEFITS

There is no direct benefit to you. However, your participation will contribute to improving reflective practice in teacher education and may inform curriculum design for preservice science teachers.

REIMBURSEMENTS

Please note that you will not receive any form of payment for participating in this research study. However, if you incur any expenses directly related to your participation—such as transportation or communication costs—reasonable reimbursements may be provided upon submission of proof of expenses.

CONFIDENTIALITY

All data will be kept confidential. Your identity will not be revealed in any reports or publications. Reflections will be anonymized and stored securely.

SHARING THE RESULTS

Findings will be shared with participants through summary reports or presentations. Results may also be published in academic journals or presented at conferences, but no individual identities will be disclosed.

RIGHT TO REFUSE OR WITHDRAW

Your participation in this study is entirely voluntary. You have the right to refuse to participate or to withdraw from the study at any point without any penalty or negative consequence. If you choose to withdraw, any information you have provided will be excluded from the study upon your request.

WHO TO CONTACT

This study was approved by the Research Ethics Review Committee of Pamantasan ng Lungsod ng San Pablo. If you have any questions at any time about this study, or if you experience any non-normative sensations as a result of participation, you may contact the researcher whose contact information is on the first page. If you have any questions regarding your rights as a research participant, or if problems arise which you do not feel you can discuss with the Principal Investigator, please feel free to contact the following: Director for Center for Research and Development – Jennifer D. Regoris, LPT, MAEd; or you may also email us at ovpriplsp@gmail.com; or by calling (049) 508-7295.

Examining Pre-Service Teachers' Reflective Narratives in Science 102: A Solo Taxonomy Approach to Pedagogical Growth and Instructional Decision-Making

CERTIFICATE OF CONSENT

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study.

Print Name of Participant: _____ Signature of Participant: _____ Date: [MM/DD/YYYY]: _

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Print Name of Researcher: JOHN ROLDAN C. DIMAANO Signature of Researcher: ____
Date: [MM/DD/YYYY]: 01/05/2026

Reviewed by:

Approved by:

Jay Ann Consignado-Octoman
Adviser

Christian Dior S. Diaz
University Data Privacy Officer

APPENDIX C

EXAMINING PRE-SERVICE TEACHERS' REFLECTIVE NARRATIVES IN SCIENCE 102: A SOLO TAXONOMY APPROACH TO PEDAGOGICAL GROWTH AND INSTRUCTIONAL DECISION-MAKING

Instruction: This guide is designed to help you reflect on your experiences in integrating Science 102 concepts into classroom practice. Your responses will provide valuable insights into how you connect theory with pedagogy, articulate your reasoning, and demonstrate levels of reflective thinking.

How to Respond:

1. Read each prompt carefully. The guide is divided into three constructs:
 - a. Integration of Science 102 concepts into instructional decisions
 - b. Articulation of reasoning behind pedagogical choices
 - c. Levels of reflective thinking
2. Answer in narrative form. Write your responses in complete sentences or short paragraphs. Be honest and detailed, sharing both successes and challenges.
3. Use examples when possible. Connect your reflections to specific lessons, classroom experiences, or instructional decisions.
4. Engage with scenario-based prompts. Imagine yourself in the given situations and explain how you would respond, including the reasoning behind your choices
5. There are no right or wrong answers. The goal is to capture your thought process and growth as a Pre-service science teacher.

Confidentiality:

Your reflections will be used for research purposes only and will be treated with respect and confidentiality

REFLECTIVE NARRATIVE GUIDE

EXAMINING PRE-SERVICE TEACHERS' REFLECTIVE NARRATIVES IN SCIENCE 102: A SOLO TAXONOMY APPROACH TO PEDAGOGICAL GROWTH AND INSTRUCTIONAL DECISION-MAKING

CONSTRUCT	GUIDING QUESTIONS
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Examining Pre-Service Teachers' Reflective Narratives in Science 102: A Solo Taxonomy Approach to Pedagogical Growth and Instructional Decision-Making

Integration of Science 102 Concepts into Instructional Decisions	Which specific Science 102 ideas influenced your instructional decisions? How did these concepts shape your choice of teaching strategies, materials, or assessment methods? Reflect on challenges you faced in applying Science 102 knowledge to teaching demonstration.
Articulation of Reasoning Behind Pedagogical Choices	Explain why you selected particular teaching methods for the lesson. What factors (student needs, content complexity, classroom context) guided your decisions? Provide an example of how you adjusted your approach when initial strategies did not work as planned.
Scenario-based reflective thinking	If students struggled with a key concept, how would you modify your instruction and why? Reflect on how your teaching philosophy has evolved since engaging with Science 102.

APPENDIX D

REFLECTIVE QUESTIONNAIRE VALIDATION TOOL

Name of Validator: _____ Position: ____ Validator's Signature: _____

_____ Date of Validation: _____

Direction: Please refer to the following criteria and rating scale provided below. Indicate the degree of validity for each criterion based on the attached questionnaires. Please check (/) only one from the scale.

Rating Scale:

5	-	Very much valid
4	-	Very valid
3	-	Moderately valid
2	-	Not so valid
1	-	Not valid

INDICATOR	5 Very much Valid	4 Very valid	3 Modera tely valid	2 Not so valid	1 Not valid
The instruction of the questionnaire is easy to understand by the respondent					

Examining Pre-Service Teachers' Reflective Narratives in Science 102: A Solo Taxonomy Approach to Pedagogical Growth and Instructional Decision-Making

2. The questionnaire is easy to administer					
The questionnaire has reasonable length for the respondents to answer.					
4. The questionnaire's items are appropriate for the level of understanding of the respondents					
5. The contents are relevant to the study					
6. The contents are relevant to the program					
7. The questionnaire's items are clearly stated					
The questionnaire's items are focused on what they intend to measure					
The instrument is not offensive to the intended respondents and/or any member of the community					
The questionnaire can be used for program evaluation purposes.					

Adopted: Research Validation Tool For Survey Questionnaire (Cerado, 2023)

APPENDIX E

Guided Reflective Journal (Scaffolded by SOLO Levels)

Instructions: Reflect on your recent Science 102 lesson or learning experience. Answer each section progressively. Write complete and thoughtful responses.

A. Unistructural Level

Identify a single important aspect of your teaching or learning experience.

1. What is one key concept or activity you learned or applied in your lesson?
2. Why do you think this concept is important?

B. Multistructural Level

List and describe several relevant ideas or experiences.

3. What are two or more strategies, concepts, or observations from your lesson?

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4. Briefly explain each:

C. Relational Level (Connecting Ideas)

Explain how the ideas you listed are related to one another.

5. How do these concepts or strategies work together in your teaching?

Examining Pre-Service Teachers' Reflective Narratives in Science 102: A Solo Taxonomy Approach to Pedagogical Growth and Instructional Decision-Making

6. How did these relationships affect student learning or your understanding?

D. Extended Abstract Level

Apply your understanding beyond the current context.

7. How can you apply these insights to future teaching situations or other subjects?

8. What new ideas or improvements can you propose based on your reflection?

APPENDIX F

Lesson Planning with SOLO Integration

Instructions: Develop a short lesson plan and align each component with SOLO levels.

Lesson Topic: _____ **Grade Level:** _

A. Learning Objectives (Classify Using SOLO Levels)

Objective	SOLO Level (Check One)
	Uni ☐ Multi ☐ Relational ☐ Extended
	Uni ☐ Multi ☐ Relational ☐ Extended
	Uni ☐ Multi ☐ Relational ☐ Extended

B. Teaching Strategies and Activities

1. What teaching strategies will you use?

2. Explain how these strategies promote deeper understanding:

C. SOLO Reflection on Lesson Design

3. Does your lesson:

- ☐ Present isolated facts (Unistructural)
- ☐ Include multiple but separate ideas (Multistructural)
- ☐ Show connections between concepts (Relational)
- ☐ Encourage application beyond the lesson (Extended Abstract) Explain your answer:

D. Extension and Adaptation

4. How can this lesson be adapted for different learners or contexts?

5. How can you extend this lesson to promote critical or higher-order thinking?

Part III: Self-Assessment Rubric

Criteria	Beginning	Developing	Proficient	Advanced
Depth of Reflection	Single idea	Multiple ideas	Connected insights	Abstract/generalized thinking
Clarity	Unclear	Some clarity	Clear	Highly coherent
Application	None	Limited	Practical	Innovative