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Research Article

Science Learning Through Realia and Manipulative Media: An Application of Bandura's Social Learning Theory

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ABSTRACT

Purpose of the study: This study explored how realia and manipulative media contribute to students' perceived learning in science, particularly in terms of knowledge retention anchored in Albert Bandura's Social Learning Theory that investigates how these instructional materials are utilized to gain a deeper understanding of students' learning experiences and perceptions.

Methodology: A phenomenological qualitative research design was used to scrutinize the experiences of eight Grade 10 learners from the St. Pius X section, Holy Trinity College of General Santos City, Philippines. Data were gathered through semi-structured interviews, audio-recorded, transcribed, and analyzed thematically. The interview protocol and ethical guidelines were taken into consideration to ensure the study's trustworthiness.

Main Findings: The use of realia and manipulative media enhances learners' ability to visualize scientific processes, improves memory retention, and increases engagement and interest in lessons. However, challenges such as limited access to materials and lack of guidance were noted as barriers to full participation and effective learning. The findings significantly emphasize the importance of thoughtfully integrating realia and manipulative media into science instruction to promote meaningful, relevant, and responsive learning experiences.

Novelty/Originality of this study: The educational benefits of tangible materials are well-documented quantitatively; a critical gap in understanding the lived experiences of learners navigating these tools remains unexplored while explicitly framed within the retention component of Bandura's Social Learning Theory. Through providing adequate empirical evidence, this study offers paramount insights by capturing the nuanced, firsthand perspectives of students as they socially construct scientific knowledge.

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1. INTRODUCTION

Science education serves as a vital foundation for national progress, yet it continues to face challenges in terms of student engagement, retention, and meaningful understanding of concepts. In many classrooms, instruction remains heavily dependent on passive lectures and rote memorization, which fail to sustain learners' interest and hinder their ability to recall and apply knowledge in real-life contexts. This issue is particularly evident in the Philippines, where science literacy is crucial for addressing socio-economic and technological demands but remains alarmingly below global benchmarks. Specifically, the Programme for International Student Assessment (PISA) results reveal that Filipino students ranked second to last in science among 81 participating countries, scoring an average of 356 points—significantly below the OECD average of 485 [1]. This empirical data underscores a critical deficiency in scientific literacy, pointing to an immediate need for more innovative and learner-centered instructional approaches.

The rapid decline of Filipino learners' performance in international assessments is a severe systemic crisis. This trend directly threatens the successful implementation of curriculum reforms and stifles the pipeline for future chemists, biologists, and engineers who are vital to driving national science and technology innovations. Educational literature indicates that this problem stems largely from outdated pedagogical strategies that detach abstract concepts from real-world applications; therefore, exploring tangible interventions must be prioritized. The utilization of realia (real-world objects) and manipulative media has emerged as a viable solution to enhance cognitive outcomes and knowledge retention. According to Albert Bandura's Social Learning Theory, learning is not merely behavioral but a cognitive process that occurs in a social context through observation [2]. For modeling to successfully translate into learning, four interconnected sub-processes must occur: attention, retention, motor reproduction, and motivation. Realia and manipulative media act as highly engaging physical models that capture student attention. Under the retention component, learners form mental representations or visual "codes" of these physical objects, storing them into long-term memory for later recall and cognitive application [2]. Delos Santos and Fiscal [3] emphasized that active learning strategies, including hands-on activities, serve as vital mediators of knowledge retention in science classrooms.

Despite the established theoretical benefits of physical manipulatives, existing literature suffers from a distinct gap. While numerous quantitative studies have measured generalized retention scores and test outcomes, there is a stark scarcity of qualitative investigations exploring how junior high school learners internally process these experiences. Specifically, little is known about how students articulate the internal cognitive transitions between observing a physical manipulative and forming a mental schema for memory recall. This gap underscores the need for a study that centers Grade 10 students' perceptions and experiences. To address this, the Philippine government enacted Republic Act No. 11899 [4], establishing the Second Congressional Commission on Education (EDCOM II) to review and reform the state of education. More recently, the Philippine Business for Education [5] highlighted urgent reforms to address declining literacy and science learning outcomes, stressing the need for innovative teaching strategies. . On the other hand, the study is grounded in Bandura's Social Learning Theory, which situates science learning within the framework of retention component [6]. Rumjaun and Narod [7] further argue that Social Learning Theory bridges behaviorism and cognitive theory, making it especially relevant for science education. Furthermore, this study aligns with the 1987 Philippine Constitution [8], which guarantees the right to quality education, reinforcing the state's commitment to improving classroom practices. By investigating students' direct insights, this study provides an actionable problem-solving plan: it bridges abstract cognitive theory with concrete classroom practice, offering educators a blueprint for designing high-retention science modules. Generally, this study aimed to describe Grade 10 student achievers' learning experiences in science when realia and manipulative media are used, particularly in terms of retention, and to explore their perceptions of the role of memory recall and understanding in learning science concepts.

Social Learning Theory by Albert Bandura has been applied [9] in this study, which emphasizes that learning occurs not only through direct experience but also through observation, imitation, and interaction within a social context. Thus, Bandura identified four essential components: attention, retention, reproduction, and motivation, which explain how individuals obtain, internalize, and apply knowledge. For this study, the retention component was the main focus to discover how instructional materials such as realia and manipulative media affect students' learning experiences in science. As well, this framework provided a strong theoretical foundation for examining students' perceived learning in science through the use of realia and manipulative media.

In the context of this study, Grade 10 students were viewed as active learners who gain scientific knowledge through observation, interaction, and hands-on engagement. The use of realia and manipulative media in science instruction provides students with concrete learning models that enhance understanding, improve retention, and support the reproduction of scientific concepts and procedures. Grounded in Social Learning Theory, this study justified the assumed connection between the use of realia and manipulative media and students' perceived science learning, as learning is strengthened when students observe meaningful models, directly engage with materials, and are motivated by relevant and experiential learning environments.

2. LITERATURE REVIEW

2.1 Realia an Manipulative Media in Science Instruction

Realia and manipulative media are considered to be one of the effective instructional materials, most especially in science discipline. These tools have been used to supply gaps in learning, allowing teachers to attain students' learning outcomes. Interactive, material-based resources significantly enhance student engagement and comprehension when effectively integrated into lessons [10]. On the other hand, Garcia et al. [11] noted that limited access to hands-on materials reduces opportunities for experiential learning, which is essential for developing both procedural and conceptual knowledge.

Students who learned through realia demonstrated higher science test results and retention compared to those who received traditional classroom instruction [12]-[15]. The efficiency of realia applies across learners, as the principle of concreteness establishes meaningful connections between abstract concepts and learners' developmental stages, thereby supporting age-appropriate learning and improved memory retention.

The study conducted by Amores and Guaman [16] revealed that young learners who acquired vocabulary through realia demonstrated stronger retention and more effective practical usage compared to those who learned through abstract materials and memorization. A study by Zaida [17] further revealed that authentic learning environments supported by realia enhance lesson effectiveness by enabling students to connect grammatical rules with real-world contexts. Definitely, realia and manipulative media are highly effective instructional tools that transform abstract concepts into concrete, hands-on learning experiences, enhancing students' understanding and long-term retention [18].

2.2 Enhanced Conceptual Understanding Through Hands-On Learning

Science education in the current decade has increasingly emphasized hands-on learning as a primary driver for deep conceptual understanding. Hands-on learning has been widely recognized as an effective approach for improving students' conceptual understanding, particularly in science education where many concepts are abstract and difficult to visualize. The use of realia and manipulative media allows learners to interact directly with instructional materials, transforming theoretical ideas into concrete experiences that support deeper comprehension and retention [19].

Research highlights that visualization plays a crucial role in science learning. Cardoso and Silva [20] emphasized that observable experiences help learners understand abstract scientific models and processes more effectively. Similarly, Rau and Herder [21] found that physical and virtual manipulatives enhance conceptual learning by enabling students to engage cognitively and physically with instructional content.

The Cognitive Theory of Multimedia Learning further explains that students learn more effectively when verbal information is combined with visual and hands-on experiences [22]. Hands-on activities reduce cognitive overload and support the integration of new knowledge with prior understanding. Moreover, Hattie [23] reported that visible and interactive learning experiences significantly improve student achievement, engagement, and long-term retention. Studies also indicate that active experimentation helps learners overcome difficulties associated with abstract topics by allowing them to construct knowledge through direct experience [24].

2.3 Active Learning Strategies and Retention

Effective methods in instruction are the cornerstone of quality education, and educators have long found ways to improve learning outcomes. From the traditional lecture into modern classrooms of today, from the teacher-centered approaches that have been used in the past to the student-centered methodologies that have surfaced and emerged, we have witnessed a transformation in how knowledge is delivered and acquired. The changes in instructional strategies throughout the years reflect the continuous search for more effective ways to engage learners and enhance their academic skills and achievements through the use of dynamic teaching, cooperative methods and active learning strategies in science learning [25]. These techniques foster meaningful interaction and responsive learning environment between students and teachers, enabling educators to address students' needs and current demands effectively, improve understanding holistically, and ensure that the knowledge and skills acquired are retained and performed in accordance to the learning outcomes [3].

Yunzal et al. [26], in a study conducted in the Philippines, found that incorporating hands-on materials and real-world applications increased students' interest, enhanced analytical skills, and led to better academic results. The utilization of realia, manipulative media, and digital tools in science education highlights the shift toward student-centered, interactive learning [27]-[28]. These strategies enable students to connect abstract concepts to concrete experiences, foster engagement and collaboration, and improve understanding, retention, and practical application of knowledge.

2.4 Student Engagement and Motivation in Hands-On Science

Student engagement and motivation are essential factors that influence effective science learning. In contemporary science education, there has been increasing recognition that students learn more effectively when they actively participate in the learning process rather than passively receive information through lectures.

Several studies emphasize the importance of hands-on activities in improving engagement and motivation among science learners. Kanapathy and Azhari [29] found that hands-on STEM activities significantly enhanced students' enthusiasm, participation, and academic performance. Similarly, Tindan and

Anaba [30] concluded that experiential science activities improve conceptual understanding and critical thinking by transforming abstract scientific concepts into concrete and observable experiences.

In addition, Tanghian et al. [31] highlighted that innovative and learner-centered teaching strategies improve learner engagement and problem-solving skills. Ahmed et al. [32] found that teaching-learning materials significantly improve learners' comprehension, retention, and academic performance, especially among visual learners. In general, this suggests that student engagement and motivation significantly improve when science instruction incorporates hands-on learning experiences through realia and manipulative media.

2.5 Challenges in the Use of Realia and Manipulative Media

Effective instructional methods hold an important role in creating meaningful, responsive, and engaging learning experiences for students, especially through student-centered approaches that encourage active participation in classroom activities. However, despite their benefits, challenges still exist in the effective use of realia and manipulative media in the classroom. The effective implementation of active learning depends on clear instructional strategies and strong teacher support to enhance participation and engagement [10]-[33]-[34]. Oschwald [35] similarly stated that unclear or ambiguous directions can lead to confusion and reduced involvement, emphasizing the need for structured guidance.

Studies also consistently support the effectiveness of active instructional methods compared to lecture-based or PowerPoint-based teaching. Kozanitis and Nenciovici [36], and Yuksel et al. [37] found that active instructional approaches improve students' interest, motivation, engagement, and academic performance more effectively than traditional teaching methods. Similarly, Šorgo and Lang [38] observed that although PowerPoint is commonly used in biology classrooms, students prefer more interactive and hands-on learning methods such as laboratory activities, models, videos, and animations to visualize learning.

2.6 Albert Bandura's Social Learning Theory

In the educational setting, it is evident how educators modify teaching pedagogies for effective learning to happen. Most of them also value the philosophies of education as these theories offer elucidation on how to make students feel engaged while considering their different learning styles. As Bandura's Social Learning Theory, people acquire knowledge through direct experience and observation. This theory provides a theoretical lens for understanding the importance of observation, modeling, and guided interaction in science instruction [9]. Therefore, role models play a crucial role in determining how people act and how well they perform in school [39]. In science classes, teachers who demonstrate students the scientific procedures help in remembering the material and gain confidence in exploring science-related knowledge. Thus, this idea is supported by Olwan [39], Bouchrika [40], and Arishaba [41] who mentioned that role models help students remember information better.

Albert Bandura's Social Learning Theory generally emphasizes its essential contribution in explaining how students acquire, retain, and apply scientific knowledge through observation, modeling, and meaningful engagement. Across various educational contexts, retention emerges as a central cognitive process that determines whether learned information and behaviors are stored and later retrieved, particularly when learning experiences are concrete, socially mediated, and connected to prior knowledge. This component reflects on how far students gained from the experience; it also connects with the purpose of engagement, observation, and modeling.

3. RESEARCH METHOD

A phenomenology-type of qualitative research was employed in this study to explore and describe the experiences and perceptions of Grade 10 Junior High School students who belong in the star section regarding science instruction that integrates realia and manipulative media, anchored on the retention component of Albert Bandura's Social Learning Theory. The phenomenological approach was selected to execute in-depth exploration and scrutinization of the subjective experiences, perceptions, and interpretations of the participants [42]. This approach enabled to understand meaning from experiences, uncovering meaningful insights [43]-[44]. The study involved eight Grade 10 Junior High School learners from the star section, St. Pius X, at Holy Trinity College of General Santos City. These students had prior experience using realia and manipulative media in science instruction, making them well-suited as informants for the research focus. Consistent with the principle of data saturation, a sample size of eight is deemed sufficient to capture diverse yet in-depth perspectives for phenomenological analysis [45]. For this study, a non-probability technique, specifically purposive sampling was employed to deliberately select participants who can provide most relevant and meaningful insights for the study.

Data were collected through semi-structured interviews, face-to-face with the selected Grade 10 learners that were labeled as P1, P2, P3, P4, P5, P6, P7, and P8. Each interview lasted approximately 35 minutes at a location and time convenient for the participants. On the day of the interview, the accomplished consent forms from the participants were collected. Before conducting, a short orientation was held to provide participants with a clear understanding of realia and manipulative media, as well as the purpose of the study, the nature of their participation, and their rights as participants to ensure smooth transaction and informed consent. After obtaining the required permissions and completing the orientation, face-to-face interviews were conducted. With the consent of each participant, the interviews were also audio recorded to ensure accurate documentation of the responses. The acquired interview data were carefully reviewed to ensure the accuracy of the content and messages conveyed by the participants. Throughout the conduct of the entire data collection process, the study strictly followed all the ethical standards to prevent any form of misrepresentation or misleading of participants, thereby upholding the integrity of the research and protecting the rights of all the involved parties.

This study employed the thematic analysis approach developed by Braun and Clarke [46] to examine students' experiences and perceptions regarding the use of realia and manipulative media in science learning. Thematic analysis was selected because it provides a flexible yet systematic method for identifying, analyzing, and interpreting patterns of meaning within qualitative data. The analysis followed the six phases proposed by Braun and Clarke: familiarization with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final report.

The criteria of dependability, credibility, confirmability, and transferability are also important in establishing trustworthiness in qualitative research. This study on science learning through realia and manipulative media, these criteria were applied to strengthen the validity and integrity of the findings as supported by Lincoln and Guba [47] as cited by Stahl and King [48]. Dependability has been given importance through carefully documenting each step of the research process, including the preparation of consent letters, the conduct of interviews, and the transcription and analysis of data. Credibility was paramount in sense to demonstrate the plausibility and genuineness of the findings. On the other hand, in order to guarantee neutrality and objectivity, confirmability was considered. Transferability also ensured the degree to which the findings can be applied in other contexts. Generally, by prioritizing dependability, credibility, confirmability, and transferability, the researchers ensured that the study is trustworthy and contributes meaningfully to science education.

Ethical guidelines were strictly followed to make sure that the researchers did not take part in actions that may abuse or take advantage of others. This study was carried out with a strong focus on ethical standards and the welfare of everyone involved. This study prioritized administering informed consents to the participants, emphasized the importance of data privacy throughout the research process in compliance with the Data Privacy Act of 2012 (Republic Act No. 10173) [49], promoted voluntary participation to connect with the right persons involved in the study, established fairness and equality through gender sensitivity, and fostered cultural sensitivity through considering the institutional cultural aspect.

4. RESULTS AND DISCUSSION

The Experiences of Learners on the Use of Realia and Manipulative Media in Science Learning in Terms of Retention

The research question describes how students experience science learning when realia and manipulative media are used during instruction, particularly in terms of retention. Table 1 presents the essential themes on the experiences of learners in the utilization of realia and manipulative media in science instruction, particularly in terms of retention. Thus, the frequency labels used in this study were adapted from Hill et al. [50] under the Consensual Qualitative Research framework. A theme was categorized as general when it was expressed by almost all participants (7–8 participants), typical when expressed by more than half of the participants (4–6 participants), and variant when mentioned by only a few participants (2–3 participants).

Table 1. The Experiences of Learners in Science Learning with Realia and Manipulative Media in Terms of Retention

Major Themes	Core Ideas	Frequency of Responses
Enhanced Conceptual Understanding of Lessons	Improved ability to visualize scientific processes	General
	Hands-on activities clarify abstract science concepts	Typical
Improved Memory Retention	Learning experiences create lasting memories	General
	Visual and hands-on experiences support recall	General
Increased Engagement and Interest in Learning	Hands-on learning makes science fun and engaging	General

Major Themes	Core Ideas	Frequency of Responses
Challenges in the Use of Realia and Manipulative Media	Reduced boredom compared to lecture-based instruction	Typical
	Difficulty participating due to lack guidance and instructions	Variant
	Limited opportunities to use realia and manipulative media	Typical

Enhanced Conceptual Understanding of Lessons

One of the overarching themes that emerged from the learners' experiences in science instruction with realia and manipulative media is the enhanced understanding of lessons. Thus, students consistently shared that engaging directly with materials allowed them to better grasp complex concepts and retrieve information from the topics taught by the teachers. Improved Ability to Visualize Scientific Process is the core idea that dominantly appears under this theme, which students shared that realia and manipulative media enabled them to transform abstract concepts into more concrete and observable experiences making lessons easier to understand. This active engagement strengthened their understanding and improved their ability to recall key concepts, as they could associate ideas with actual experiences rather than abstract descriptions alone. P1 stated:

> P1: *I remember the lesson more when the teacher shows something and I can actually see the process. Instead of only hearing the words, I can see how it is being carried out.*

In science learning, students support that visual aids provide enlightenment to how scientific processes are executed. Thus, observing the actual execution of a process made the lesson easier to remember compared to simply hearing verbal explanations. This implies that learners develop stronger cognitive connections when instruction involves visual demonstrations and concrete experiences. Hence, visualizations and interactive learning activities significantly improved students' conceptual understanding in learning. By allowing students to generate and observe visual representations, it helped them better understand scientific processes and increased their motivation toward learning [21].

P2 also shared that experiential learning plays an essential role in helping students construct meaningful understanding, particularly in science subjects where abstract ideas often require visualization and demonstration. She shared:

> P2: *I can describe it as very easy to understand because it is already hands-on, and the lesson can be clearly visualized. That is why I like it when there are hands-on materials because students are able to experience the lessons in real time.*

The accounts provided by P2 weave a narrative of transformation, where the shift from abstract theory to tactile exploration serves as the bridge between confusion and clarity. Moreover, the participants' statements reveal that visualization is a critical component of effective science learning. From the theoretical framework of Albert Bandura's Social Learning Theory, these student accounts provide empirical proof of the attention and retention sub-processes of observational learning [9]. Bandura posits that for modeling to be successful, a learner must first accurately attend to and perceive the critical features of the modeled behavior or stimulus [9]. In this study, the realia and manipulative media serve as the physical model. When teachers utilize tangible media instead of relying strictly on lectures, they capture the student's direct attention, minimizing cognitive drift. P1 and P2's ability to 'see the process in real time' allows them to convert these external physical manipulations into internal cognitive representations—a process Bandura defines as cognitive coding [9]. This mental imagery is what anchors the scientific concept into the student's long-term memory archive, dramatically facilitating later retrieval.

These findings are heavily supported by the work of Fiorella and Mayer [19], who emphasized that active learning environments involving hands-on experiences significantly improve students' understanding because learners are able to cognitively process information through direct engagement and observation. By explicitly connecting your data to Fiorella and Mayer's principles, it becomes clear that tactile manipulatives prevent cognitive overload by splitting the processing load across multiple sensory channels.

The findings paint a compelling picture of the classroom as a living laboratory, where the integration of hands-on tools and manipulative media serves as the vital link between curiosity and mastery. On the other hand, the success of manipulative media lies in its ability to translate abstract data into a visual language that students can easily decode. By bridging the gap between external observation and internal thought, these tools do more than provide an experience; they honor the specific ways in which different minds process and store the scientific world. P5 and P6 added:

> P5: *I understand better because I am a visual learner. It is different when actual objects are used compared to only explanations or pictures.*
>
> P6: *It becomes easier to understand because as a visual learner, when I actually see what my teacher is explaining, I remember it more and understand it better.*

The responses of P5 and P6 strongly emphasize the importance of learning styles in shaping students' comprehension, particularly the visual learning preference. Both participants clearly expressed that they understand lessons more effectively when they are presented with visual and tangible representations rather than through verbal explanation alone. These insights show that realia works because it acts as a bridge for the visual mind. By moving beyond spoken words or flat diagrams, these materials turn invisible theories into a solid reality that students can see and touch. While Pashler et al. [50] note that the commercial concept of rigid learning styles is heavily debated in educational psychology, they emphasize that multimodal tools like realia benefit all students equally by making lessons clearer and reducing overall cognitive load. Further research by Fiorella and Mayer [19] confirms that when students pair active visualization with physical interaction, they bridge the gap between abstract theories and concrete experiences.

Building on the cognitive benefits of hands-on tools, these findings reveal a deeper connection between how students feel and how they learn. By replacing abstract lectures with tangible demonstrations, educators do more than just clarify difficult concepts, they spark a genuine interest and motivation in their students. In the context of Social Learning Theory, this represents the *motivation* component of Bandura's model [9]. When an instructional method generates a positive emotional state, it acts as an intrinsic reinforcement mechanism, boosting students' self-efficacy and driving them to actively preserve the knowledge they have acquired. This shift suggests that the true value of manipulative media lies in its ability to combine academic clarity with a positive emotional experience, making the study of science both more effective and more inspiring. As P4 and P7 stated:

> P4: *It is very fun because you can actually see what is happening. Instead of just reading or listening to lectures, when there are real objects or hands-on materials, you understand better how the lesson works.*
>
> P7: *We understood it more compared to just words on the PowerPoint. When the teacher shows how something works, you are able to see it in real life.*

These experiences reveal that science instruction achieves its greatest impact when it moves beyond the digital screen and into the realm of live demonstration. By trading static PowerPoint slides for real-time experiments, educators transform the learning process from a passive act of reading into a dynamic, "fun," and emotionally engaging experience. This is further supported by Hattie [23], whose research on "visible learning" confirms that active engagement and hands-on interaction are among the most powerful ways to boost student achievement. Similarly, studies from Fiorella and Mayer [19] emphasize that when students observe and interpret real-life demonstrations, they do not just understand the lesson better, but they also stay motivated and remember the information longer.

Hence, these results suggest that teachers should move away from text-heavy lectures and instead prioritize hands-on activities that make science more interactive and meaningful. To make this possible, schools must invest in the necessary physical resources and provide training that helps educators design lessons centered on discovery. By creating a classroom rich in visual and physical experiences, we do more than teach facts; we foster a positive, lifelong curiosity for the scientific world.

Hands-On Activities Clarify Abstract Science Concepts is also one of the core ideas under this theme that supports the ability of hands-on learning in science concepts. As P1 and P8 shared:

> P1: *I understand the lesson better because sometimes I cannot fully understand it when I only see it on the screen or PowerPoint. Especially since I am also a visual learner.*
>
> P8: *It is difficult to imagine when it is explained only through words because we only read written explanations. However, when there are hands-on models, I understand better and can better imagine how things work.*

The responses of P1 and P8 highlight the importance of hands-on learning in improving students' understanding of science concepts. Taken together, the responses reveal that realia and manipulative media emphasized that rather than simply memorizing information from verbal explanations or written notes, students are able to actively engage with concepts through observation and experience. These results align with Mayer's [22] Cognitive Theory of Multimedia Learning, which suggests that students learn best when they can connect verbal explanations with visual and hands-on experiences. Similarly, studies also found that when students move from passively listening to actively testing concepts through experiments, they overcome the difficulties of abstract topics [24].

Several participants also emphasized that science lessons become easier to understand when teachers use visual demonstrations and manipulative materials during instruction. Learners explained that observing how concepts work in actual situations allowed them to better process and remember the lesson compared to relying only on written explanations or PowerPoint presentations. As P4 and P7 stated:

> P4: *It is very fun because you can actually see what is happening. Instead of only reading during the lesson, using real objects or hands-on materials helps you understand how the lesson really works.*

P7: *I understood it better when the teacher explained and demonstrated it properly rather than relying only on words in the PowerPoint. We understood it more because you could actually see it in real life.*

The responses of P4 and P7 confirm that science concepts become more understandable when verbal explanations are supported by visual demonstrations and concrete learning materials. These responses highlight a strong preference for live demonstrations over text-heavy PowerPoint slides. When students see a process happen in real time, they can easily connect abstract ideas to the physical world, making the lesson feel more relevant and less intimidating. Research from the work of Hattie [23] also confirms that these visual strategies reduce mental strain and significantly boost achievement. By making learning "visible" through demonstrations, educators help students process complex ideas more efficiently, leading to better memory and a stronger ability to apply what they have learned.

Moreover, the results of this study suggest that science classrooms should be intentionally designed to facilitate visual learning through the integration of models, simulations, and hands-on demonstrations. By creating an environment where abstract concepts are made visible and observable, educators can address diverse learning needs, particularly for those who thrive under observation-based instruction. Consequently, teacher training programs must prioritize the development of skills needed to deliver these visually enriched lessons, as strengthening an educator’s capacity to use experiential tools directly elevates instructional quality and student performance.

From the perspective of Albert Bandura’s Social Learning Theory, these hands-on experiences can be seen as an application of observational learning and modeling. Bandura [9] posits that learners acquire knowledge not only through direct experience but also by observing others and imitating modeled behaviors within a social context. In the science classroom, teacher demonstrations, guided experimentation, and active supervision serve as models that students observe and replicate during hands-on activities. By providing opportunities to observe, perform, and receive feedback, realia and manipulative media support the social learning process, enhancing students’ understanding, retention, and ability to apply scientific concepts in meaningful ways.

Improved Memory Retention

One of the emerging themes of the learners’ experiences in science education that became apparent is improved memory retention. Most students viewed that interactive strategies are essential to enhance their learning and retention of scientific concepts. Learning Experiences Create Lasting Memories is the first core idea that demonstrates how science lessons become more meaningful and unforgettable when students actively participate in authentic and engaging learning experiences.

The participants’ statements on the other hand reveal that active engagement creates stronger cognitive connections compared to passive learning. When students are allowed to manipulate materials, observe demonstrations, and participate in activities, they form mental images that help them reconstruct the lesson even after a long period of time. These experiences become deeply embedded in memory because learners associate scientific concepts with actions, emotions, and visual representations. P1, P2 and P7 explained:

P1: *I remember more when realia are involved because I can picture what we did. Words are easy to forget, but the experience can be replayed in my mind.*

P2: *I really remember the lesson more when hands-on materials are used because it becomes deeply ingrained in my mind.*

P7: *I am a visual learner, so I understand the lesson faster when examples are shown, and it becomes easier for me to remember.*

These responses strongly demonstrate that memory retention becomes more effective when learning is concrete, visual, and participatory. The participants emphasized that words alone are often temporary and easy to forget, while experiences involving real objects and hands-on activities create vivid mental representations that remain accessible in memory. These findings strongly align with Yaam et al. [13] and Hutasoit et al. [12], who found that students exposed to realia and experiential learning strategies demonstrated stronger retention and higher academic performance compared to students exposed only to lecture-based instruction. Similarly, Amores and Guaman [16] explained that tangible referents strengthen memory retention because learners are able to connect concepts with physical experiences.

From the perspective of Bandura’s Social Learning Theory, these student reflections provide a direct, qualitative look at the retention sub-process of observational learning. Bandura posits that information cannot be retained unless it is internally organized and cognitively stored in an active symbolic format, either through imaginal or verbal coding systems [2], [9]. P1’s assertion that an experience can be 'replayed in my mind' is classic cognitive imagery coding in action. Because tactile and realia-based instruction layers multi-sensory variables onto a single lesson, it gives the brain a wealth of cognitive hooks. This complex coding makes the resulting mental schema incredibly robust against the typical decay associated with passive text-heavy learning.

According to McLeod [2], learners remember information more effectively when they observe, experience, and mentally process meaningful activities.

The lasting impact of concrete learning experiences was also highlighted by other participants. Students explained that lessons involving experiments and manipulatives remained memorable even after several years, while lessons delivered through passive instruction were often forgotten. P3 and P6 shared:

> P3: *I can still remember it, but if you ask me about other topics where we did not use those materials, it becomes difficult for me to remember.*
>
> P6: *The pH strips activity was still back in Grade 7, but I can still remember it. However, some of our current lessons that are not engaging have already been forgotten.*

The enduring nature of memories formed through meaningful experiences is highlighted by these responses. The participants demonstrated that lessons involving active engagement remain memorable even years later because they are associated with concrete activities and emotional involvement. P6's ability to recall a Grade 7 pH strip experiment while in Grade 10 provides stark empirical support for the long-term sustainability of experiential schemas.

The participants' reflections therefore suggest that effective science education is not only about delivering content but also about creating experiences that remain meaningful long after instruction has ended. Therefore, these findings support Ubimago [14] and Amos et al. [15], who found that authentic instructional materials, and interactive and manipulative activities improve both achievement and retention because learners actively connect knowledge with experience. Delos Santos and Fiscal [3] further explained that active learning strategies strengthen long-term retention by encouraging students to participate in the learning process rather than remain passive recipients of information.

On the other hand, other participants also emphasized the role of models, real objects, and tangible materials in simplifying recall and making scientific concepts easier to understand. P4, P5, and P8 noted:

> P4: *When we use real objects or hands-on materials, it stays longer in the memory.*
>
> P5: *It lasts longer for me, and I remember better whenever objects are used for learning.*
>
> P8: *When there is a model, it becomes easier to recall in the mind compared to just reading words.*

By providing visual and physical representations of complex ideas, these materials facilitate active engagement and reduce the cognitive burden on students, who might otherwise struggle to visualize processes through verbal or written explanations alone. Research participants emphasized that direct interaction with observable materials allows for more effective mental organization and a deeper, more accessible understanding of the subject matter.

The findings align with Zaida [17], who emphasized that authentic learning environments improve lesson effectiveness by connecting scientific concepts to real-world contexts. Ubimago [14] and Amos et al. [15] also found that charts, models, and realia enhance retention because learners are able to interact with information in more meaningful ways. Delos Santos and Fiscal [3] further explained that hands-on learning activities strengthen knowledge retention by increasing student engagement and participation. Bandura's Social Learning Theory also supports these findings by explaining that retention becomes stronger when learners encode experiences through observation and sensory engagement.

Generally, the participants highlight different but interconnected dimensions of the core idea Learning Experiences Create Lasting Memories. Across all responses, the findings consistently demonstrate that students remember science lessons more effectively when learning is concrete, participatory, visual, and connected to real-world experiences. Supported by previous studies and grounded in Bandura's Social Learning Theory, the evidence suggests that meaningful learning experiences create stronger cognitive connections than passive forms of instruction.

Visual and Hands-On Experiences Support Recall is the second core idea that explains how experiments, models, visual aids, authentic objects, and manipulative activities help students retrieve and remember scientific concepts more effectively. The participants explained that hands-on experiences allow them to mentally reconstruct lessons because they remember not only the information itself but also the activities connected to it. P2 and P3 shared:

> P2: *The cloud in a bottle activity for gas laws was memorable because you were the one who actually performed it.*
>
> P3: *In tectonic plates, I was able to clearly see the differences, and that was what strongly stayed in my mind.*

By engaging in hands-on experiments and direct visual observation, learners move beyond the rote memorization of textbook descriptions toward a deeper, more resilient understanding rooted in personal experience. Participants noted that this active involvement fosters a sense of cognitive and emotional investment, which helps embed complex concepts into long-term memory. As supported by Olwan [39], who found that students retain learning materials more effectively when they engage in observation and modeling activities. Arishaba [41] similarly emphasized that hands-on exposure improves retention because learners actively construct understanding rather than passively receiving information. Bouchrika [40] also explained that experiential learning strengthens memory retention by connecting scientific concepts with meaningful experiences.

Other participants also highlighted the role of visual aids and realia in helping them understand and retain science lessons more effectively. P1, P6, and P7 stated:

> P1: *Especially because I am also a visual learner, I understand the lesson more when realia are involved.*
>
> P6: *More information is retained in my mind because there are visual aids.*
>
> P7: *I understood it better compared to word-for-word explanations on PowerPoint because you can actually see it in real life.*

Participants noted that these visual experiences enable learners to associate abstract scientific principles with specific images and movements, creating a mental framework that makes information easier to organize and retrieve. In addition, the participants' reflections imply that visual materials support long-term understanding because learners can mentally revisit the images and demonstrations connected to the lesson. The research reinforces the scholarly consensus that authentic learning environments and manipulative strategies are vital for long-term knowledge retention. By aligning these findings with the work of Zaida [17] and Delos Santos and Fiscal [3], it becomes evident that active participation transforms abstract scientific principles into meaningful real-world connections.

This phenomenon illustrates a crucial aspect of Bandura's theory regarding *symbolic reproduction* [9]. When a student physically manipulates realia, such as generating a 'cloud in a bottle' (P2), they are executing motor actions that correspond directly to conceptual structures. When it comes time for evaluation or exam recall, the student doesn't search for abstract textbook definitions. Instead, they rely on the robust cognitive reference points built during that personal, physical activity, easily reconstructing the scientific principle behind the phenomenon.

The participants also emphasized how authentic objects and repeated visual experiences serve as memory triggers that support the recall of previous lessons. P4 and P8 explained:

> P4: *When you see the objects again another time, you remember the experience and the lesson as well.*
>
> P8: *It helps me because it assists me whenever I try to recall past lessons.*

These responses demonstrate that authentic objects create strong cognitive associations that support retrieval of stored knowledge. The research indicates that memory recall is significantly enhanced when learners repeatedly encounter physical objects or experiences that serve as cognitive anchors for scientific principles. The participants' experiences therefore demonstrate that authentic objects and experiential activities are not simply supplementary classroom tools. Instead, they function as essential supports that strengthen retrieval, reinforce understanding, and sustain memory over long periods of time.

The research concludes that visual and hands-on learning experiences transcend mere temporary memorization by establishing enduring cognitive connections that underpin long-term understanding and practical application. These experiential strategies not only bolster memory retention but also cultivate essential student attributes such as confidence, curiosity, and the ability to navigate real-world scientific challenges. Within the specific context of the Philippine educational system, these findings serve as a compelling argument for a pedagogical shift toward learner-centered approaches. By prioritizing meaningful engagement over rote learning, educators can ensure that scientific knowledge becomes a functional tool for students rather than a collection of isolated facts, ultimately fostering a more profound and sustained interest in the sciences.

Increased Engagement and Interest in Learning

One of the most significant benefits of using realia and manipulative media in science instruction is the way it increases student engagement and interest. This theme highlights that when lessons go beyond words and slides, and instead involve tangible experiences, learners are more likely to stay focused, participate actively, and retain knowledge effectively.

Hands-On Learning Makes Science Fun and Engaging. Learners emphasized that science becomes more enjoyable and memorable when they actively participate in experiments using realia and manipulative media. These tangible experiences not only help students understand abstract ideas, but also promote an active environment for learning inside the classroom, thus turning science into a fun and engaging subject. P1, P3, and P4 stated:

> P1: *When there are realia or manipulative media involved, I become more motivated to listen.*
>
> P3: *The lesson becomes more interesting and easier to understand when the teacher teaches that way.*
>
> P4: *It is very fun because you can actually see what is happening. Instead of just reading or listening to lectures, when there are real objects or hands-on materials, you understand better how the lesson works.*

By facilitating active participation, these tools enhance student motivation and curiosity through allowing learners to bridge the gap between abstract theory and physical reality. Specifically, participants noted that experiencing phenomena firsthand, such as the application of gas laws, converts theoretical concepts into observable practices, making the subject matter more accessible and fun. Supporting these findings, Kanapathy and Azhari [29] found that hands-on STEM activities significantly improved student performance and enthusiasm, demonstrating that interactive learning approaches increase both engagement and comprehension. Likewise, Tindan and Anaba [30] concluded that experiential science activities enhance conceptual understanding and critical thinking by transforming abstract ideas into concrete experiences that learners can directly observe and manipulate.

Participants also give emphasis to how educational tools such as realia and manipulative media influence visualization, leading to effective learning. P2, P7, and P8 supported:

> P2: *I can describe it as very easy to understand because it is already hands-on, and the lesson can be clearly visualized. That is why I like it when there are hands-on materials because students are able to experience the lessons in real time.*
>
> P7: *We understood it more compared to just words on the PowerPoint. When the teacher shows how something works, you are able to see it in real life.*
>
> P8: *I understand more and I can better imagine how things work. When the model is hands-on, I can clearly see how it really works.*

From the standpoint of Albert Bandura's Social Learning Theory, these findings clearly illustrate the vital attention and motivation sub-processes of observational learning [2, 9]. Bandura emphasizes that an individual cannot learn effectively through observation unless they accurately attend to the distinctive features of the modeled stimulus [9]. The testimonies of P1, P3, and P8 show that tangible realia serve as high-salience models that naturally command attention, effectively screening out classroom distractions. Furthermore, Bandura's framework connects learning tightly to reinforcement systems [9]. When P4 highlights that the process is 'very fun' and P1 notes an increased 'motivation to listen,' they are experiencing intrinsic reinforcement [9]. This positive emotional response satisfies the motivation sub-process, transforming a routine lesson into an active, self-sustaining learning experience where students are driven to mentally retain what they observe.

The participants highlight the importance of visualization and real-time demonstration in making science learning more engaging and understandable. Their accounts reveal that students learn more effectively when they are given opportunities to observe scientific processes directly rather than relying only on verbal explanations or textual presentations. The integration of realia and manipulative media enhances student engagement by transforming abstract scientific concepts into visible, relatable, and accessible experiences. By transitioning from passive recipients to active participants, learners develop deeper comprehension and heightened curiosity through the firsthand observation and analysis of phenomena. This shift toward student-centered pedagogy aligns with the findings of Tanghian et al. [31], who link innovative strategies to improved problem-solving skills, and Yunzal et al. [26], who observe that experiential approaches effectively concretize complex ideas for Filipino STEM learners.

In addition, schools should provide sufficient instructional resources and laboratory materials to support interactive learning experiences that promote active participation and meaningful understanding. P5 and P6 explained:

> P5: *I understand better because I am a visual learner. It is different when actual objects are used compared to only explanations or pictures.*
>
> P6: *It becomes easier to understand because as a visual learner, when I actually see what my teacher is explaining, I remember it more and understand it better.*

The responses provided by P5 and P6 underscore the necessity of aligning science instruction with individual learning preferences, specifically for visual and tactile learners. Collectively, these accounts suggest that integrating concrete materials facilitates a more effective information-processing environment by grounding theoretical discourse in tangible, observable evidence.

These results mirror the work of Ahmed et al. [32], which highlighted how concrete materials significantly improve memory and grades for visual learners. By adopting a student-focused approach that integrates real-world tools and manipulatives, schools can lower learning hurdles, boost student morale, and encourage more active involvement. To achieve this, it is essential for educational leadership to provide teachers with the training and resources needed to meet these varied cognitive requirements.

Reduce Boredom Compared to Lecture-Based Instruction is one of the core ideas in the participants' accounts with the contrast between traditional lecture-based instruction and interactive, hands-on approaches. This subtheme illustrates how interactive strategies reduce boredom, sustain motivation, and foster deeper comprehension compared to passive lecture formats. The following responses illustrate how learners perceive the difference between lecture-heavy lessons and those enriched with hands-on and visual materials. P1 and P3 stated:

P1: *When I only keep listening, I often feel sleepy. But when realia and manipulative media are involved, I become more motivated to listen.*

P3: *It makes the class more different because it's more fun and engaging compared to classes that only involve writing on the board and using PowerPoint.*

These accounts demonstrate that active involvement is vital for keeping students interested, as they find more meaning in lessons that prioritize physical participation over simply receiving information. These insights emphasize how experiential learning acts as a powerful motivational tool. This perspective is reinforced by Kanapathy and Azhari [29], who observed that hands-on STEM tasks drastically boost classroom participation. Similarly, research by Tindan and Anaba [30] suggests that these experiential strategies sharpen both critical thinking and conceptual mastery because students are active participants in their own intellectual growth.

Therefore, breaking up the monotony of standard instructional routines creates a dynamic environment where students are more likely to stay curious and involved. Furthermore, institutional support for learner-centered models, which prioritize active participation, is essential for boosting both student engagement and overall academic achievement. P2 and P7 also noted:

P2: *If it's only through PowerPoint presentations, others may get bored, and sometimes I also get bored.*

P7: *It engaged us more directly, gave us more energy, and made the lessons more intriguing instead of just showing the lesson.*

Analyzing P1's feeling of being 'sleepy' alongside P7's experience of gaining 'more energy' uncovers a profound cognitive shift regarding internal mental strain. Traditional, lecture-heavy frameworks force students to construct mental models entirely out of abstract verbal cues. This places an intense load on working memory, resulting in cognitive fatigue, boredom, and disengagement. Realia and manipulative media act as external cognitive scaffolds. By shifting a portion of the processing load onto tactile and visual modalities, these materials free up cognitive space. This reduction in mental strain directly alleviates classroom boredom and helps students maintain focused attention over longer periods.

These responses align with the findings of Tanghian et al. [31], who emphasized that student-centered and interactive teaching strategies improve learner engagement and participation. Similarly, Ahmed et al. [32] found that visual and manipulative materials enhance comprehension and retention by helping learners process concepts through concrete representations, supporting P2's experience with hands-on learning. The research suggests that science education is most effective when teachers transition away from lecture-heavy methods toward a curriculum rich in hands-on activities and visual aids. By providing students with the tools to witness and manipulate scientific phenomena, schools can shift the classroom from a place of passive listening to a hub of active inquiry. This learner-centered approach, supported by both physical resources and interactive strategies, not only sustains student motivation but also ensures that scientific concepts are deeply understood rather than merely memorized.

As a result, the study highlights that incorporating realia and manipulative media serves as a catalyst for student success, shifting science education from passive absorption to active investigation. By allowing students to physically handle materials and observe phenomena in real time, teachers can dismantle the monotony of traditional lectures. This hands-on approach bridges the gap between abstract scientific theories and their real-world applications, making the subject matter both more enjoyable and significantly easier to grasp.

Challenges in the Use of Realia and Manipulative Media

One of the essential themes that emerged from the learners' experiences in science instruction with realia and manipulative media is the presence of challenges in their use during the learning process. This theme highlights the importance of planning and effective guidance, as learners emphasized that without sufficient support and clear instructions, the use of real and manipulative objects may not always lead to effective understanding.

Difficulty Participating Due to Lack of Guidance and Instructions is a key idea that emerged under this theme, which learners emphasized that unclear guidance and instructions have become a barrier to fully engage in science activities using realia and manipulative media, because when instructions were vague or not clearly demonstrated, students found it challenging to follow procedures and participate effectively in tasks. From the perspective of participants, teacher monitoring and clear procedural guidance are crucial to ensure inclusive participation and accurate execution of hands-on activities with realia and manipulative media. P2 stated that:

P2: *But I also noticed that some of my classmates were not really involved, so they did not join the experiment. After that, I noticed that they did not really understand the lesson well. ...because if you are a teacher conducting an experiment with your students in one room, I think you should monitor them to make sure that they are also learning something.*

When it comes to getting students involved in class, a teacher's role is really important. P2 emphasized that a teacher's active facilitation and monitoring are vital to student engagement. Consequently, she concluded that when conducting experiments in a shared space, teachers must provide close supervision and structured support to ensure every learner remains on track and succeeds. From the theoretical perspective of Albert Bandura's Social Learning Theory, these instructional breakdowns directly impede the third sub-process of observational learning: motor reproduction. Bandura establishes that cognitive retention of a model is not enough; to convert an internal schema into successful physical behavior, a learner must possess the requisite motor skills and receive immediate corrective feedback to adjust their execution. When a teacher introduces realia without structured behavioral modeling or procedural checkpoints, students cannot successfully reproduce the observed concept. P2's observation that disengaged students 'did not really understand the lesson well' confirms that when the replication phase fails due to a lack of instructional scaffolding, the entire social learning sequence collapses.

The emergence of this finding is supported by recent research on guided instruction and active learning environments. Thus, Nguyen et al. [10] found that effective active learning relies on clear instructional strategies and strong teacher support to improve student participation and engagement. Similarly, Oschwald [35], states that ambiguous instructions can lead to confusion, frustration, and reduced involvement among learners Participants also experienced minor difficulties during hands-on activities, especially while performing experiments, as some steps were carried out incorrectly because the instructions and guidance were vague. As the activity progressed, a few learners became unsure of the proper procedures, which affected their ability to achieve the expected outcome. P7 added:

> P7: *There were minor problems when we did the 'cloud in a bottle activity because we made some mistakes.*

Although many participants recognized the value of hands-on activities, their responses show that effective learning is strengthened not only through the use of materials but also through clear guidance and instructions. This experience suggests that hands-on learning becomes more effective when it is paired with clear instructions and proper guidance. Without structured teacher monitoring, physical manipulatives risk becoming overwhelming toys rather than cognitive tools, inducing high split-attention effects and procedural frustration.

Furthermore, Gunn et al. [33] and Mendoza et al. [34] highlight the importance of teacher guidance in hands-on learning. Clear instructions, ongoing monitoring, and timely feedback help ensure all learners participate effectively and perform tasks correctly, reducing confusion and enhancing understanding in experiments. Generally, learners identified several challenges in the use of realia and manipulative media, particularly when guidance and instructions are unclear, which affects their ability to fully engage and understand the lesson. Difficulties such as confusion in handling materials, incorrect execution of procedures, and lack of teacher monitoring made it harder for students to participate actively and follow the intended learning process. Without clear directions, some learners became hesitant or disengaged, resulting in gaps in understanding compared to those who were actively involved.

The findings highlight important implications for classroom practice. With the use of realia and manipulative media, these show that learning becomes more meaningful when teachers provide clear instructions and consistent guidance. With proper support, learners are more confident, engaged, and able to understand tasks better, while lack of guidance can lead to confusion and reduced participation. This highlights that effective hands-on learning depends not only on materials, but also on how teachers guide and support students throughout the activity.

Limited Opportunities to Use Realia and Manipulative Media is another key idea under this theme, which learners emphasized that having fewer chances to interact with hands-on materials hindered their ability to fully engage in science activities. From the participants' perspectives, limited resources and access to realia and manipulative media reduced hands-on engagement. P5, P6, and P8 stated that:

> P5: *Actually, we are the ones who are usually asked to make them, and sometimes we are also the ones who provide them, but they are real objects.*
>
> P6: *They don't really use many hands-on materials, but there are pictures in the PowerPoint. The ones we used in previous years were pH strips. We tested the pH levels of bleach, calamansi, and others to differentiate their pH levels.*
>
> P8: *I cannot really describe it because my teacher does not always use materials, but when the practice teacher of Sir taught us, he used a syringe to explain gas laws…*

The participants' experiences show that using interactive materials, such as a syringe to explain gas laws, helps students understand science concepts more clearly. So, when there are limited opportunities to interact with these materials, it is definitely hard for students to make science learning engaging and meaningful for them. In the context of the localized Philippine educational environment, P5's disclosure that students must provide or construct their own realia reflects systemic logistical barriers that disrupt instructional continuity.

This supports Nguyen et al. [10], who stated that material-based resources improve student engagement and understanding when effectively used in lessons. Similarly, Garcia et al. [11] explained that limited access to such materials reduces opportunities for active participation and experiential learning. Therefore, using concrete materials in science teaching helps students develop both conceptual understanding and practical knowledge.

Participants also highlighted that learning is less engaging and harder to grasp when lessons rely solely on words or PowerPoint presentation, as they cannot visualize concepts clearly. P5, P6 and P8 stated that:

> P5: *Actually, I experienced that before, especially during our biology time when we really did not have activities using objects. So, it was just traditional learning*
>
> P6: *Our teacher does not really use hands-on materials or actual products.*
>
> P8: *The problem with our adviser or science teacher is that I cannot imagine it properly through words because when examples are given, it is only through PowerPoint and everything is just words. So, I cannot imagine it properly.*

When evaluated against Bandura's motivation and reinforcement sub-processes, these structural omissions weaken long-term learning goals. Bandura points out that vicarious and internal reinforcement, such as the genuine excitement of discovery, sustains cognitive effort over time. When students are subjected to a constant loop of text-dense slides, their internal motivation declines. P8's inability to 'imagine it properly' shows the cognitive wall students encounter when they are deprived of structural models, leading directly to passive classroom disengagement.

Studies consistently supported the idea that active instructional methods are more effective than lecture or PowerPoint-based teaching in improving students' interest, motivation, engagement, and academic performance [36]. However, many classrooms still rely heavily on PowerPoint presentations, which can lead to passive learning experiences. Similarly, Šorgo & Lang [38] observed that although PowerPoint is widely used in biology classrooms, students prefer more interactive and hands-on learning methods such as laboratory activities, models, videos, and animations.

Moreover, learners have found that interactive approaches in science, including the use of realia and manipulative materials, greatly improve understanding, knowledge expansion and retention, and engagement compared to lecture-based methods. Limited opportunities to interact with hands-on materials were seen as a barrier, as students reported difficulty performing experiments, practicing and visualizing procedures, engaging hands-on activities, and contextualizing abstract concepts to real-life applications. Lessons that relied mostly on slides, pictures and pure lectures, without physical models, real objects or tangible examples, were harder to visualize, observe, and definitely less interesting.

Thus far, this study has demonstrated that the utilization and integration of realia and manipulative media in science instruction improves learners' retention, understanding, and engagement. Learners were able to grasp concepts more effectively by interacting with tangible materials, which helped them visualize abstract processes and connect lessons to real-life situations. Hands-on activities and visual aids strengthened memory and increased students' interest in learning. These interactive strategies also help students build connections between knowledge and experience, allowing them to reflect and apply learnings obtained to actual world situations. However, some challenges were identified, including limited opportunities to use materials and difficulty participating due to unclear instructions or insufficient guidance. These challenges suggest that while realia and manipulative media are beneficial, their effectiveness depends largely on proper implementation and teacher support. Therefore, this study provides significant knowledge to ameliorate science learning difficulties, because while technology is advancing, we must also innovate pedagogies to enhance students' knowledge and skills to prepare them for the future.

In this study, Albert Bandura's Social Learning Theory serves as a framework for understanding how learners retain scientific knowledge. The findings show that the use of realia and manipulative media definitely supports retention through allowing students to learn in interactive lessons, observe demonstrations, visualize procedures, and engage in hands-on activities. Hence, the presence of tangible learning materials supported memory formation by transforming abstract concepts into observable and repeatable experiences, thereby reinforcing the retention component of Bandura's Social Learning Theory. Furthermore, Social Learning Theory emphasizes the importance of guided instruction and reinforcement in achieving successful learning outcomes, which revealed in this study that when teachers provided clear instructions, demonstrations, and continuous supervision, students were more confident in performing activities and were able to participate more actively. Conversely, when instructions were unclear or materials were limited, some learners struggled to follow procedures and fully engage in the tasks.

Lastly, the findings of this study underscore the importance of maintaining a balanced and well-planned approach to the use of realia and manipulative media in science instruction. While these materials enhance visualization, engagement, and memory retention, their effectiveness relies on consistent utilization, clear teacher guidance, and sufficient availability of resources. Generally, the results suggest that the integration of realia and manipulative media transforms science learning into a more interactive and experiential process, giving learners countless opportunities to actively construct knowledge and retain concepts more effectively. Therefore, the thoughtful and systematic use of these instructional tools is essential in promoting meaningful learning experiences, improving retention, and fostering long-term understanding of scientific concepts.

Synthesizing the collective experiences of the learners across all themes reveals a definitive educational generalization: the quality, depth, and longevity of secondary science literacy are direct functions of instructional design that balances structural multi-sensory modeling with explicit pedagogical scaffolding. Traditional, lecture-heavy frameworks and word-dense digital presentations create an unsustainable cognitive burden on students, leading to rapid working-memory fatigue, widespread classroom boredom, and immediate information decay. Conversely, organizing science instruction around physical models, interactive realia, or real-time manipulative media naturally captures student attention and triggers intrinsic motivation by transforming abstract, intimidating scientific theories into visible, relatable realities. This direct interaction allows students to process information across multiple cognitive pathways, creating resilient visual and mental schemas that resist cognitive decay over long periods of time.

Crucially, however, the pedagogical success of these tools is completely conditional; physical media do not function as self-contained solutions. Their educational value is entirely dependent on the presence of structured teacher guidance, explicit procedural modeling, and equitable resource distribution. Without targeted, hands-on instructional support and continuous formative supervision, complex activities lose their focus, turning what should be powerful learning tools into sources of confusion and student disengagement.

5. CONCLUSION

The utilization of realia and manipulative media enormously influence and enhance learners' ability to visualize scientific processes, improve memory retention, and increase engagement and interest in lessons. Students reported that hands-on experiments, demonstrations, and models transformed abstract scientific concepts into concrete, memorable experiences, bridging the gap between theory and real-world application. However, challenges such as limited access to materials and lack of guidance were noted as barriers to full participation and effective learning. Anchored in Bandura's Social Learning Theory, the study highlights how observation, modeling, and active participation support retention and conceptual understanding. As prospective science educators and curriculum developers, addressing the challenges surrounding student performance in science remains a critical priority. At Holy Trinity College of General Santos City, Philippines, the integration of realia and manipulative media is observable across classrooms and laboratories, facilitating an active pedagogical environment. However, there remains a need to evaluate how these materials specifically expand student knowledge and improve instructional efficiency, understanding, and retention. While existing literature often prioritizes quantitative academic outcomes, this study sought to address a significant research gap by centering on the lived experiences, observations, and social interactions of the learners. By exploring students' perceived learning efficiency, this research aimed to inform the development of learner-centered instructional practices and support systems that optimize the use of tangible tools for meaningful engagement in diverse science contexts. The study emphasized the importance of thoughtfully integrating realia and manipulative media into science instruction to promote meaningful, relevant, and responsive learning experiences. This study therefore urged schools and teachers to address the practical challenges of material availability and instructional clarity to maximize their benefits. Future researchers may explore how these approaches influence long-term academic performance across different grade levels and disciplines, as well as how they can be adapted to overcome the limitations observed in this study. Development of instructional frameworks is also encouraged to balance interactive learning with the cultivation of independent critical thinking. Future studies may design structured approaches for incorporating realia and manipulative media that enhance conceptual understanding, engagement, and retention while promoting learners' autonomy and analytical skills.

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AUTHOR CONTRIBUTIONS

Rey Mar Engcong led the research writing process, conceptualized and initiated the study, formulated the research question and research design, and supervised the data collection and analysis. Nicole Andrea Botes contributed to the literature review, participated in data collection and analysis, and assisted in manuscript preparation. Marielle Cordova contributed to the literature review, participated in data collection and analysis, and provided valuable insights that enhanced the development of the study. Elayza Rae Lara took the lead in preparing the data collection materials, contributed to the literature review, and assisted with data analysis. Rey Melitante contributed to the literature review, participant selection process, and data collection and analysis. Haya Jane Elan supervised the research team, reviewed and critically revised the manuscript, and provided guidance throughout the study and publication process. All authors contributed to the study, reviewed the manuscript, and approved the final version for publication.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

INFORMED CONSENT STATEMENT

This study prioritized administering informed consents to the participants. During the interview, the participants presented their parent and personal's consents to show that they joined the study voluntarily. This has been done through writing a clear document that includes all important details to be shared with those taking the interview, including clear explanations of how the interview will be conducted. Participants were required to sign the informed consent to confirm their willingness to take part in the study. Parental permission was also given importance since the participants are Grade 10 students and are still not in the appropriate age. The interview forms excluded any participants' names, and their answers were kept strictly confidential. All images in this article have been authorized and are the property of the authors.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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