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Multisensory supplementary instructional material in earth and space science

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Abstract

This study determined the effect of the developed multisensory supplementary instructional material in enhancing scientific knowledge of grade 9 learners. Moreover, the study assessed significant difference between the pre-and post-assessment scores of the learners who used the instructional material and the significant relationship between the perceived acceptability of the multisensory supplementary instructional material and the students' level of scientific knowledge. Using descriptive-developmental research, it involved 30 grade 9 students during the school year 2022-2023. A cognitive diagnostic test in terms of remembering, understanding, applying, analyzing, evaluating, and creating was used to identify the least-mastered competency among the topics. Pre- and post-assessment, which measured the scientific knowledge of the students, went through internal and external validation of the panel of examiners and group of teachers. Results revealed a significant difference between the pre-and post-assessment scores of the students as to content and epistemic knowledge whereas there is no significant difference found in the procedural knowledge. It can be inferred that the students enhanced their scientific knowledge after the utilization of the multisensory supplementary instructional material. However, there is no significant relationship obtained between the students' perception on the acceptability of the material to their level of scientific knowledge.

Keywords: *multisensory supplementary instructional material, least-mastered competency, scientific knowledge, learning preferences*

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1. Introduction

The Philippine Department of Education (DepEd) established a new standard at the aftermath of the pandemic dubbed as *"new normal in education*" which utilize both modular and face-to-face classes to further address the issues and concerns on health and safety and educational concerns of every student. This ensure learning would be available, pertinent, and maintain its quality regardless of the circumstance. Hence, pupils were taught via modular distance learning, particularly in remote locations with little to no internet access. However, several studies argued the effect of modular distance learning, emphasizing its effectiveness (Roque, 2022; Serrano & Farin, 2022; Boholano et al., 2022; Fernandez, 2021; de Ocampo, 2023; Lachica & Pineda, 2023; Tanucan et al., 2023; Aksan, 2021; Capinding, 2022; Villanueva & Campos, 2022) and ineffectiveness (Dangle & Sumaoang, 2020; Dargo & Dimas, 2021; Bustillo & Aguilos, 2022; Talimodao & Madrigal, 2021; Cajurao et al., 2023) in achieving the subject learning outcomes. Despite the varying degree of agreement and disagreement on the modular system, many studies still recommend development of contextualized learning materials (Aviles et al., 2021; Kaminski & Sloutsky, 2020) to help students learn better (Jou et al., 2022; Humana & Rahmat, 2022; Suryawati & Osman, 2018; Manjares & Pasia, 2023) and facilitate systematic teaching and learning process (Garcia et al., 2022; Astrero et al., 2020; Ambrose et al., 2013; Johar et al., 2018; Manlunas, 2022). Hence, in the Philippines, development of contextualized learning module is still highly encouraged.

One of the common subjects in school that is highly contextualized based on the needs of students in the module distance learning is science. Researchers and educators alike believe that students will be able to comprehend things more thoroughly through the use of appropriate and readily available materials (Dunlosky et al., 2013; Frimpong, 2021). The availability of textbooks, proper chalkboards, mathematics kits, science kits, teaching guides, science guides, audio-visual aids, overhead projectors, and other materials is one of the most important components of the instruction-learning process (Bukoye, 2018). It is imperative that teachers provide their students with resources outside of textbooks when teaching science; these resources might include a range of educational tools that would surely improve the students' understanding of the material. According to Munna and Kalam (2021), while traditional teaching techniques like lectures, textbook discussions, and the like are valuable and ought to be employed in the classroom, educators also need to modify their methods to fit the requirements of each individual student. Hence, teachers should also incorporate a variety of strategies into every part of their education to accommodate the different learning styles of their pupils.

Since innovative flexible learning practices have been shown to improve students' learning results (Müller et al., 2023; Kariippanon et al., 2019; Müller & Mildenberger, 2021), several schools throughout the world have already replaced conventional classroom arrangements with them (Kim, 2020). In the flexible learning, students should be provided with additional support in the form of relevant study materials in order to fill any gaps in the learning process. Similarly, teachers are highly encouraged to create supplemental instructional materials to help students fill in the gaps between modular learning to in-person sessions specifically with students' limited and insufficient resources. This will help students stay on track and recover from their previous learning.

Given the effectiveness of contextualized learning materials and the necessity of flexible learning practices, this study aimed to create and validate supplemental multimodal educational material to help students grasp science more deeply and to advance their scientific knowledge. Through a variety of exercises aligned with the least-mastered competencies, this study identifies potential improvements in the learners' performance.

2. Literature Review

2.1 Multisensory Supplementary Instructional Material

It is imperative for every teacher to develop instructional materials that will boost students' understanding and will encourage them to do more in science. According to Hofstein and Naaman (2018), pupils cannot understand science unless they have worthwhile practical experiences in the school laboratory. Without significant hands-on experiences in the classroom laboratory, science cannot be engaging to pupils. Hence, the K–12 basic education courses must utilize the pupils' 21st-century skills including information, media, technology, life, and professional skills, as well as learning and innovation skills. For this, Suarez (2018) suggests that usage of particular learning materials coupled with appropriate teaching styles were capable of developing learning capabilities of students. These abilities could differ from discipline to discipline and could be cultivated through particular techniques based on the subject and the technique.

It has been demonstrated that using multimodal instructional materials is a successful teaching method across a variety of subject areas. According to Shams and Seitz (2013), multisensory learning strategies can more closely replicate real-world situations and are therefore superior for learning. Mayer (2014) suggests that incorporating multiple sensory modalities into instructional materials can enhance student learning. Therefore, while it may not be necessary to tailor instructional materials to individual learning preferences, it is beneficial to include a variety of sensory modalities to engage students and promote learning.

Researchers from several fields have noted various advantages of using a multisensory approach. According to Manches (2011), using manipulatives—both real-world and virtual—such as multisensory technologies—allows students to effectively articulate what they have learned. Through role playing, materials that are commonly used, and other practical ways, students get familiar with fundamental abilities. They can thus better understand real-world problems through multisensory approach exercises, preparing them for a variety of careers, vocations, and other platforms for skill exhibition. The students satisfy their desire to learn through a variety of senses, including constructing models, learning through manipulatives, adding depth to scenes, collaborative learning techniques, discussion, and demonstrations. Thus, the use multisensory materials are cushion to learners with learning needs.

According to Obaid (2013), when teachers use multisensory instruction in their classroom, they are teaching the students to link letters with the written symbol. Multisensory activities are based in learning by whole brain that means, the best way to teach concepts is through the involvement of multiple areas in the brain. This is done through adding auditory or visual components to reading assignments, like pictures, illustrations or even online activities. In this manner, you can help students develop stronger and increased literacy skills. This has been manifested in the study of Davidson and Wesimer (2014), when children had improved performance after receiving instruction using a multisensory approach that relied on visual, auditory, kinesthetic, and tactile activities. Similarly, Li and Li (2020) found that the students who received multisensory instruction demonstrated significantly greater gains in content knowledge and higher levels of engagement.

2.2 Least Mastered Competencies

In the Philippines, teachers need to look attentively at the least-mastered competencies (LMC) in the Basic Education Curriculum for Grades K–12. The LMC is one of the pillars on the revision of the current curriculum. In 2018, just before the health crisis broke out, as part of the Quality Basic Education reform plan and a step toward internationalizing Philippine basic education, the Philippines participated in PISA for the first time on behalf of the Organization for Economic Co-operation and Development (OECD). The country's fifteen-year-old children scored lower in reading, math, and science than students in most of the countries and economies that took part in PISA 2018. In the Philippines, 22% of pupils achieved Level 2 or higher in science. These pupils are able to recognize the proper explanation for common scientific events and can apply this knowledge to determine whether a conclusion is valid based on the evidence presented in simple scenarios. In science, hardly no student was a top performer, indicating they were proficient at Levels 5 and 6. These kids may apply their knowledge of and about science in a variety of ways, independently and imaginatively (OECD, 2018).

Learning difficulties are frequently caused by students' poor understanding of the material, particularly biology. According to Chinyere et al. (2020), helping students increase their understanding of subjects like biology is the most difficult task for teachers. Pupils' prior knowledge, intelligence, and motivation have an impact on these challenges. However, the teaching-learning process is at the control of the teachers. Cabual (2021) reiterates that learners have different learning pace, they learn through various activities and their unique differences and qualities became a factor that makes a teacher think of their strategies. Their different learning strategy challenges the teacher to think of techniques and approaches that promotes an increased academic performance in science and a decreased number of least-mastered competencies.

2.3 Scientific Knowledge

School closures and learning loss during the health crisis can have a long-term negative impact on the current cohort of school children (Engzell et al., 2021; Brackx et al., 2023; Hairol et al., 2023). Global evidence from past health and disaster-related emergencies show that the impact extends well beyond the period of the disaster or pandemic. It is also likely to affect the children's economic potential and productivity in adulthood, thus undermining the country’s competitiveness (Cho et al., 2021). To be able to adapt to the demands of a rapidly changing world, scientific knowledge is a must. This focus aligns scientific literacy with the growth and development of life skills. It distinguishes the need for intellectual ability in a social context, and it further specifies that everyone should be literate in science. This suggests being concerned with social demands, learning how to handle societal conflicts, and arriving at wise decisions (Yates & de Oliveira, 2016). According to Bang (2015), learning about people and the natural world is the major goal of studying science. Hence, it combines previous knowledge with new knowledge while also learning more about the fundamentals of life. Additionally, it is to make recommendations for how to integrate it into the formal education system (Sotero et al., 2020).

Scientific knowledge is very significant for an individual (Radder, 2017) although frequently used but rarely defined (Miller, 1983). The phrase "scientific knowledge" refers to both a state of mind and a body of knowledge of science and technology (PISA Assessment and Analytical Framework, 2018) that involves comprehension of scientific concepts and procedures necessary for independent judgment, involvement in civic and cultural activities, and economic output (Palines & Ortega-Dela Cruz, 2021). Understanding of scientific principles, events, and procedures, as well as the capacity to use this knowledge in novel and, occasionally, non-scientific contexts (PISA, 2018). The three types of knowledge assessed in PISA include content, procedural and epistemic knowledge.

Science literacy is vital because it provides a context for solving societal issues, and because a science-literate population can better cope with many of these issues and make educated and informed decisions that will affect their lives and the lives of their children. This includes the development of skills that can be employed in all learning areas, such as problem-solving skills, using technical terms, or applying scientific concepts and processes. Therefore, the ability to use scientific evidence is considerably more crucial than having a thorough comprehension of it. Because science touches all part of our lives, it is essential to be scientifically educated (Ajayl, 2018).

1.4 Learning Preferences

Science education has long been seen as the ultimate goal of all institutions of learning, from primary to higher education. In order to create a culture that is more advanced and evolved, educators and students have realized how important it is to teach and study about science. In order to effectively teach science courses and ensure that students obtain the skills they need to be lifelong learners, a variety of strategies, methods, and approaches have been developed over time.

Every adolescent is unique and should be taught according to his/her style of learning. Briggs and Myers (1975) put focus on the consideration of student's individual learning style in an effective teaching-learning process. Previous studies support the use of various teaching methods in order to satisfy variability of students' learning styles within educational programs (Brown et al., 2001; Alhourani, 2021; Kharb et al., 2013; Ridwan et al., 2019; Romanelli et al., 2009; Singh et al., 2016; Renzulli & Sullivan, 2009). However, researchers disagree that teachers need to alter any teaching methodology that best fit learning style of each student as learner can easily adapt to any teaching style (Prajapati et al., 2011). There would be no enhancement in academic performance by matching teaching style and student's learning style preferences (İlçin et al., 2018).

Learning style refers to the variations that people have in their approaches to learning (Rayner, 2001). The capacity to modify lessons to account for the unique characteristics of each student is crucial to educational success. In addition to understanding the value of teaching utilizing a variety of learning styles, a teacher should be providing an atmosphere that meets the needs of the students' diverse learning preferences. Understanding a student's learning style provides information about their unique preferences. It can be easier to build, modify, and develop curriculum and educational programs that are more effective when learning styles are understood. In order to enhance learning outcomes, it is crucial to assess students' preferred methods of learning (Brown et al., 2001).

According to Basit (2017), a student's learning style focuses more on how they learn during the learning process than on the subject matter being covered. Each student has a unique set of skills and preferences about how to gather and process data. Some students learn better while using visual media, such as reading. Some students may learn more effectively verbally by listening to lectures given in person, while others may learn more effectively by participating in class activities and applying what they have learned. In the study of Umali and Chua (2020), active learning approaches may help teachers gain educationally sound ideas and strategies to improve learning, teaching and assessing in a modularized context. Students, on the other hand, who will be exposed to the learning approaches may experience varied learning activities that will enhance their thinking skills.

Hence, teachers can identify and distinguish learner's preferences (Nilson, 2015; Mustafa, 2021).

The VARK model of students' learning styles developed by Neil Fleming and Baume (2006) is extensively used by researchers. The abbreviation VARK stands for Visual, Auditory, Reading/Writing Preference, and Kinesthetic. According to the paradigm, students' various methods of information interpretation are referred to as "preferred learning modes." For accessing and comprehending new knowledge, the visual learning style favors images, maps, and graphic organizers. Auditory learners benefit from speaking and listening during lectures and group discussions because it helps them comprehend new content. Mnemonics are helpful for students, and repetition is a useful study technique. The read-and-write learning style benefits most from verbal learning. These pupils may exhibit extensive note-taking or reading habits and transform abstract ideas into written works. Information is better understood by kinesthetic learners when it is presented tactilely. These pupils are active learners who learn best by doing things themselves (Ameer & Parveen, 2023).

According to Cardino and Ortega-Dela Cruz (2020), learning styles play a crucial role in how teachers demonstrate their students' understanding of the material. Rezaeinejad et al. (2015) assert that identifying the students' learning styles will enable the teacher present the lesson that students can cope with easily, make varied teaching tactics, and lead to their academic accomplishment. However, additional elements including sex, gender, and personality as well as heritage, breed, and environmental influence may also have an impact on learning styles. Peers, schools, communities, and cultures can all have an impact on this.

3. Methodology

This study used descriptive-developmental research design to determine the effect of multisensory supplementary instructional material in enhancing scientific knowledge of Grade 9 students in science. Developmental research, as opposed to simple instructional development is described by Richey and Nelson (2001) as the systematic study of designing, developing, and evaluating instructional programs, processes and products that must meet the criteria of internal consistency and effectiveness.

The respondents of the study were the 30 Grade 9 students of an integrated school in the Philippines for the School Year 2022-2023. On the other hand, the experts who corroborated the multisensory supplementary learning materials were composed of one master teacher, one head teacher from secondary public schools, two JHS science teachers from secondary public schools and one Grade 10 science subject teacher, one science coordinator, one teacher for English, and one ICT coordinator. There were eight expert respondents who validated the developed multisensory supplementary learning material.

The study used different instruments to gather data and information, which include survey questionnaire, cognitive diagnostic test, lesson exemplar and pre-and post-assessment tests. The survey questionnaire was adapted from the University of California (2006) to assess the students' learning preferences and learning challenges at home that would help in the development of the instructional material. The lesson exemplar focused on the topic "demonstrate the identification of constellations throughout the year using models," extracted from the K to 12 Grade 9 Module during the third grading period. The 50-item cognitive diagnostic test was adapted from Zamboanga Del Norte National Highschool. From the least-mastered competencies identified from the cognitive diagnostic test, the multisensory instructional material was developed. Lastly, the 30-item multiple-choice pre-assessment and post-assessment were developed based on a table of specification reflecting the learning competencies. Questions were aligned with the PISA framework, covering content, procedural, and epistemic knowledge. Clear directions were provided to prevent confusion among respondents. The pre-assessment was given before the utilization of the developed instructional material whereas the post-assessment was given after the exposure to the material.

To ensure the validity and reliability of the instruments, both internal and external validation processes were conducted. The instruments were scrutinized by a panel of experts, including the researcher's adviser, subject specialist, statistician, and technical editor, during the internal validation. All corrections and recommendations from the panelists were incorporated into the final version of the instruments.

4. Results and Discussion

Table 1 shows students' science performance before the intervention. This shows that a total of 30 students were assessed using a grading scale with four categories; 10% of the students are in the outstanding level on the first quarter then percentage decreased to 3.33% on the second quarter period. It also shows that most of the students are in the fairly satisfactory level. It means that the student has demonstrated a level of understanding and competency in the subject matter that is deemed satisfactory by the teacher based on the criteria set by the curriculum.

Table 1

Students' performance in science

Grade	First Quarter			Second Quarter		
	f	%	Level	f	%	Level
90-100	3	10	O	1	3.33	O
85-89	7	23.33	VS	7	23.33	VS
80-84	9	30	S	8	26.67	S
75-79	11	36.67	FS	14	46.67	FS

Legend: 74 and below [Did Not Meet Expectations]; 75-79 [Fairly Satisfactory(FS)]; 80-84 [Satisfactory(S)]; 85-89 [Very Satisfactory(VS)]; 90 and above [Outstanding(O)]

This grade range indicates that the student has achieved a level of proficiency that meets the minimum standard for the subject, but there is still room for improvement. On the other hand, it was evident that the majority of students were performing at a lower level during the second quarter, indicating that there is a learning gap being displayed by the pupils.

Table 2

Learning preferences of the students

Learning Preference	Mean Score	SD
Visual	24.00	5.61
Auditory	24.53	3.76
Kinesthetic	25.33	3.06
Read/Write	25.57	2.74

Legend: 32-24 (Highly Preferred); 23-16 (Moderately Preferred); 15-8 (Slightly Preferred); 8-0 (Not Preferred)

Table 2 shows the learning preferences of the students. According to the mean scores, the students like read/write learning methods slightly more than auditory, kinesthetic, and other learning methods. Additionally, their preference for visual learning is a little bit lower.

This implies that in order to properly deliver their lectures, teachers should consider the various learning preferences of their pupils. They can adapt their teaching methods to fit a variety of learners' learning preferences by including written materials, interactive exercises, and visual aids. This can improve students' comprehension and retention of the lesson and foster motivation and interest in learning to consider a variety of instructional strategies to meet their needs. The results led to the design and development of a multisensory instructional that would cater the various learning preferences of the students.

Table 3

Diagnostic test mean scores of the students as to cognitive domain

Domain	Mean	SD	Remarks
Remembering	76.00	1.770	Unsatisfactory
Understanding	78.83	9.370	Unsatisfactory
Applying	72.89	7.083	Poor
Analyzing	76.33	7.630	Unsatisfactory
Evaluating	74.52	6.485	Poor
Creating	71.73	8.193	Poor

Legend: 74 and below (Poor); 75-79 (Unsatisfactory); 80-84 (Satisfactory); 85-89 (Very Satisfactory); 90 and above (Outstanding)

Table 3 shows the mean scores of the students in the diagnostic test as to cognitive domain. It reveals that students have unsatisfactory result from the domains remembering, understanding and analyzing. The data showed that students were not able to remember concepts, definitions, names and series of events. Moreover, they may have difficulty identifying patterns or relationships between the stars in the constellation, or breaking down the topic into its constituent parts. Additionally, they are in the unsatisfactory level on the understanding domain because they cannot explain the concepts and theories about constellation using their own words. The result also showed that they are poor in the cognitive domains applying, evaluating and creating. This means that the students are poor in applying a particular context or situation to solve problems or complete tasks, they also have difficulty in combining and reorganizing the information of constellation in a novel way to form a new whole. They failed to make judgments about the topics discussed. Through this, the multisensory supplementary instructional material was designed and developed.

Table 4

Pre and post-assessment performance of the students as to scientific knowledge

Scientific Knowledge	Pre-Assessment			Post-Assessment		
	Mean	SD	Level	Mean	SD	Level
Content Knowledge	79.89	8.498	*D*	85.56	3.784	*P*
Procedural Knowledge	78.79	5.178	*D*	80.24	4.472	*AP*
Epistemic Knowledge	79.47	4.972	*D*	82.00	2.896	*AP*

Legend: 74 and below [Beginning (B)]; 75-79 [Developing (D)]; 80-84 [Approaching Proficiency (AP)]; 85-89 [Proficient (P)]; 90 and above [Advanced (A)]

Table 4 summarizes the students' pre-assessment and post-assessment performance. This shows that on the pre-assessment performance of the students, all of them are in the developing level in terms of content, procedural and epistemic knowledge. During the conduct of the pre-assessment test, majority of the respondents have least information about the topic. This suggests that based on the legend, the students struggle with understanding the topics being introduced, prerequisite and fundamental knowledge and/or skills have not been acquired or developed adequately to aid understanding. On the other hand, after the utilization of the designed and developed material, the students improved and increased their scientific knowledge scores from developing to proficient and approaching proficient level. Both in the procedural and epistemic knowledge, the students developed fundamental knowledge and skills as well as core understandings of the topics, however, they still need the guidance and assistance from the teachers and peers, yet they can transfer what they learned through authentic performance tasks. In the content knowledge, the students developed knowledge and skills and can transfer their understandings through different performance task with no guidance from the teachers and peers.

Table 5 summarizes the test of difference in the level of scientific knowledge of the students before and after the use of the multisensory supplementary instructional material. Paired t-test was employed to determine if there is a significant difference between the pre-assessment and post-assessment scores of the students as exposed to the multisensory supplementary instructional material. It reveals that upon the exposure of the students in multisensory instructional materials, significant improvements occurred in their content and epistemic knowledge.

Table 5

Test of difference in the level of scientific knowledge before and after the use of the multisensory supplementary instructional materials

Scientific Knowledge	Pre		Post		Mean Difference	t	df	Sig. (2-tailed)
	Mean	SD	Mean	SD				
Content Knowledge	79.89	8.50	85.56	3.78	5.67	3.42	29	.002
Procedural Knowledge	78.79	5.18	80.24	4.47	1.45	1.12	29	.272
Epistemic Knowledge	79.47	4.97	82.00	2.90	2.53	2.66	29	.013

*Difference is significant at the 0.05 level

During the execution of the lesson, the students participated well in the discussion. It has been observed that the students gain deeper facts, concepts, ideas, and hypotheses about the topic. The multisensory instructional materials helped students to make connections between the information they were learning to use multiple senses to process and remember the information. These also allowed them create assertions and meaning of key words like theory, hypothesis, and data. During the conduct of the study, they were able to work independently, they listened to the instruction by scanning the generated QR code. Moreover, they may listen and revisit the lesson multiple times by accessing the link of the uploaded video lesson on YouTube. Manches (2011) confirms that the use of manipulatives, both materials and virtual type such as multisensory technologies offered a suitable enabler to students to express their learning. Students are acquainted with basic skills using the role plays, materials of common use and other practical methods.

However, table shows that there is no significant difference in the pre-assessment and post-assessment scores in the procedural knowledge after the use of the multisensory instructional materials. During the conduct of the study, it was observed that the students are exposed to the material once and covered only one competency thus resulting to insufficient practice which may hinder motivation and engagement with the procedures. Additionally, limited transferability of procedural knowledge to different contexts may also be a cause to limit improvement. Finally, a lack of timely feedback and opportunities for reflection may also hindered learners' ability to identify areas for improvement. This supports the findings of

Suarez (2018) that the usage of particular learning materials and teaching styles were capable of developing learning capabilities.

Table 6

Test of correlation between the level of acceptability of the multisensory supplementary instructional material to the students' level of scientific knowledge

Scientific Knowledge	Multisensory Supplementary Instructional Material		
	Intellectual	**Life Skills**	**Affective Dev't**
Content Knowledge	-.099	.210	.137
Procedural Knowledge	-.174	-.089	.301
Epistemic Knowledge	-.045	.121	.281

**Correlation is significant at the 0.01 level (2-tailed).

Table 6 summarizes the test of relationship between the perceived level of acceptability of the multisensory supplementary instructional material to the level of students' scientific knowledge. It utilized Pearson Moment Product Correlation to find the significant relationship among variables and was tested at 5% level of confidence.

It can be observed that after the exposure to the multisensory supplementary instructional materials, students' science performance was improved, students were able to develop critical thinking skills by working independently. They were able to answer the guide questions through watching the uploaded video lesson on YouTube using the tablets assigned to them. This confirms the findings of Umali and Chua (2020) that remembering and understanding sub-skills in lower order thinking skills is greatly enhanced using collaborative approach. Through the use of multisensory kit, they were able to remember the different patterns of each constellation, they also identified some on a night sky and were able to film it as well. It is understood that their science performance increased, however their perception on the acceptability of the material has no bearing to their scientific knowledge.

Findings from this study reveal that while multisensory supplementary instructional materials exhibit the potential to enhance learning experiences, their correlation with the level of scientific knowledge is nuanced. The impact of these materials varies based on factors such as design, quality, and integration into the learning process, underscoring the significance of well-planned implementation. The research emphasizes the diversity in learning styles, indicating that the effectiveness of multisensory approaches is contingent on individual preferences. Some learners derive substantial benefits, while others may not find them as effective, highlighting the inadequacy of a one-size-fits-all approach. This underscores the need for personalized and flexible educational strategies. Furthermore, the correlation between the use of multisensory materials and scientific knowledge acquisition is influenced by the specific content being taught. The study identifies that certain scientific concepts lend themselves well to multisensory approaches, whereas others may not necessitate or significantly benefit from such materials.

In the context of effective teaching methods, the study underscores that instructional materials alone, even when multisensory, cannot guarantee improved learning outcomes. Teacher expertise, instructional strategies, and the classroom environment emerge as pivotal factors in shaping scientific knowledge, emphasizing the holistic nature of effective pedagogy. In conclusion, this study contributes insights that advocate for a nuanced and context-specific approach to the integration of multisensory materials in education, recognizing their potential benefits while highlighting the importance of considering various factors for optimal learning outcomes.

The execution of the material once may also be a reason. However, for optimal results and a deeper understanding, it is essential to encourage further exploration and engagement with the material. This can be achieved through repeated exposure, hands-on experiences, and varied learning opportunities. By providing opportunities for students to revisit the material, apply their learning in different contexts, and engage in collaborative activities, a more comprehensive understanding and mastery of the subject matter can be achieved. Therefore, while the initial execution of the material is crucial, the subsequent exploration and continued engagement with the content lead to the best results.

5. Conclusion

This study found that students highly preferred the use of visual, auditory, kinesthetic, and read/write learning modalities. Thus, learning preference variation is observed. The extent of acceptability of the developed multisensory supplementary instructional materials in terms of design elements and material content are highly acceptable. The students' perception on the acceptability of the developed multisensory supplementary instructional materials as to intellectual skills, life skills, and affective development were highly acceptable. The result of the post-assessment scores of the students in terms of content, procedural and epistemic knowledge were statistically higher than their pre-assessment scores. The study also indicates that there is a significant difference between the pre-assessment and post-assessment scores of students in their level of scientific knowledge as to content and epistemic knowledge, whereas there's no significant difference between pre-assessment and post-assessment scores of the students in terms of procedural knowledge. Thus, the null hypothesis is partially sustained. However, there is no significant relationship found between the perceived acceptability of the multisensory supplementary instructional material and the students' level of scientific knowledge. Thus, the null hypothesis is sustained.

Since the study revealed that the use of multisensory supplementary instructional materials strengthens and increases students' scientific knowledge, and has a positive impact on students' learning outcomes, it is recommended that school administrators, teachers, and students initiate the use of the material. With the utilization of the multisensory supplementary instructional material once, future researchers may conduct a study investigating why there is no significant difference obtained based on the pre- and post-assessment scores of the students in terms of procedural knowledge after the utilization of the multisensory supplementary instructional material. They may modify the multisensory supplementary instructional material to better fit with the lesson in other quarters or grade levels. They may also modify by adding more challenging activities that will promote feedback and communication with other people.

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