International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Learning Cognitive Barriers and Misconceptions in Chemistry Bridging Mastery of the Science Process Skills

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ABSTRACT

The Philippines now falls behind other nations in the globe in terms of science education, especially at the basic education level. This study focused on determining the learning cognitive barriers (LCB) and misconceptions in Chemistry (MIC) concepts and its significant relationship to the basic and integrated science process skills (SPS) of the grade 8 students. The study utilized a descriptive-correlational design using a survey questionnaire on LCB and test questionnaires on MIC and SPS. The respondents of the study consisted of 160 grade 8 learners at Godofredo M. Tan Integrated School of Arts and Trades. Based on the findings, it was discovered that they experienced literacy as a barrier in learning Science. In the test of misconception, it was found out that the learners have high misconception in terms of preconceived notions and factual misconceptions. In the result of basic science process skills test, it was revealed that the learners have "poor" performance score in observing skill and "outstanding" in classifying skill. On integrated science process skills test, it was determined that the learners have "poor" performance score in controlling variables. In conclusion, the learning cognitive barriers and misconceptions in Chemistry both have significant correlation to the learners' basic and integrated science process skills. The findings suggest that teachers may consider integrating strategies to improve the literacy skills of the students in science classes, clarify misconceptions during discussions, provide activities to practice the basic and integrated science process skills among the learners, and design intervention and enhancement programs to overall improve their learning in chemistry.

Keywords: *learning cognitive barriers, misconceptions in chemistry, basic science process skills, integrated science process skills*

1. THE PROBLEM AND ITS BACKGROUND

Introduction

As part of the Quality Basic Education reform plan and a step towards internationalizing Philippine basic education, the Philippines officially joined the Organization for Economic Co-operation and Development's (OECD) Programme for International Student Assessment (PISA) in 2018. According to the results, the Philippines had the lowest reading comprehension score and the second-lowest score in math and science among 83 countries (San Juan, 2019). Also, it is alarming that based on the recently concluded 2022 PISA, the Philippines ranked third from the bottom in Science among 81 participating countries (Montemayor, 2023). It is quite a common sight for students to encounter many challenges in learning Chemistry. Thus, the pressure is on the educator to ensure that the lessons, competencies, and skills they need to acquire will come across. Still, it is possible that there are many other things to consider in assessing the skills of the learners in science.

Chemistry is a world of prevalent phenomena and fascinating experimental activities and thriving knowledge to comprehend the realms of the natural and artificial. Despite the topic's connection to everyday events, students nevertheless struggle to understand it. The abstract nature of the concepts covered in the curriculum contributes to students' trouble understanding it to some level. It is not sufficient for pupils to grasp the theories, symbols, and terminologies utilized in the study of Chemistry concepts. The teaching language and materials that the chemistry teachers utilize in the classroom must be transformed into meaningful representations (Ortiz, 2019).

A major obstacle to the efficient learning and comprehension of basic concepts in chemistry education is misconceptions. This is clear even among students in the 7th and 8th grades. It is empirical to understand the misconceptions in these levels which could build and lead up until they reach the end of their junior high school, or even beyond this level. According to the research of Nuić & Glažar (2023), students frequently have trouble understanding that matter is made up of particles, which causes them to misinterpret states of matter, mixtures, and pure substances. Many students believe that the total mass of a solution can be less than the sum of the masses of its constituent parts, which is an example of a fundamental misunderstanding of conservation of mass (Derman & Eilks, 2016). The fact that this misconception may arise from a lack of foundational knowledge in earlier grades emphasizes the necessity of early intervention to dispel these misconceptions before students face more complex chemistry concepts in higher grades (Mamombe et al., 2019).

Through formal education in schools or informal experiences, students gain knowledge of their surroundings. These experiences are frequently used to generate insights based on the perspectives of the students. Due to this, some studies were conducted to gather data on students' comprehension, particularly when it came to acquiring science topics to determine whether there were misconceptions among students about their lessons in science in relation to their perspectives. In conclusion, a misconception in science can be defined as student ideas drawn from real-world experience or informal education that are poorly structured and give rise to the wrong interpretation of a scientific topic (Soeharto et al, 2019).

Science process skills are the abilities that make learning easier, engage students, help them take ownership of their education, and make learning more lasting. Scientists employ these techniques as a more refined version of the scientific process. It is empirical to build science process skills if you want to utilize science in your daily life as well as for science (Mirana, 2019). A solid foundation in these skills is essential for maximizing students' engagement and performance in chemistry, as Harta et al. (2019) point out that developing these skills entails comprehending the basic chemistry concepts that students will encounter in real-world applications.

In this study, the researcher attempted to determine the students' cognitive barriers and misconceptions towards Chemistry in relation to their science process skills.

Background of the Study

The Philippines now falls behind other nations in the globe in terms of science education, especially at the basic education level. Aside from the 2018 and 2022 PISA results mentioned from the introduction of this study, the Philippines performed poorly compared to other participating countries in the Second International Science Survey (SISS) and Third International Mathematics and Science Study (TIMSS). The country placed nearly last among the seventeen (17) countries that took part in this extensive assessment of educational accomplishment according to SISS. In addition, results from National Achievement Assessments reveal that Science remains the most challenging subject area in elementary education, after mathematics (Robledo, 2018). Thus, there is still a problem in education with the declining performance on the National Achievement Test (NAT) in science and mathematics (Maranan, 2017). Two factors such as learning cognitive barriers and misconceptions in Chemistry may contribute to their process skills. Misconceptions in science education are tenacious and difficult to dispel. Students that have trouble understanding some scientific concepts will likely have trouble understanding similar concepts in the future, which will lead to poor performance when learning science (Soeharto & Csapo, 2022).

Being a science teacher at GMTISAT, it is quite alarming for the researcher to find out that the assessment scores that the higher-grade learners get during nationwide assessments garner low average in Science. Through informal interviews with the test-takers, they find Chemistry-specific questions tricky to answer, especially those that they've learned about during their 7^{th} and 8^{th} grade lessons. Upon looking into the topics and learners in the lower levels, the researcher noticed that the grade 8 students may have learning cognitive barriers and misconceptions regarding the topics they've discussed during their classes in Chemistry which can play a role to their mastery of the science process skills. She chose the grade 8 learners to be her respondents since their lessons in grade 7 and grade 8 Chemistry serve as the foundational knowledge that learners should be equipped with, to effectively learn and understand deeper lessons in Chemistry as they reach higher grade levels. She believes that addressing issues early on in education is important to inculcate correct understanding of lessons to the minds of the learners which they will utilize as they move to higher levels. Thus, the researcher wants to carry out this study and determine whether the students' learning cognitive barriers and Chemistry misconceptions have an impact on their science process skills.

Conceptual Framework

This study was anchored on Cognitive Barriers of Chew & Cerbin (2020), Types of Misconceptions in Science by Suprapto (2020) and "Science – A Process Approach" by the American Association for Advancement of Science (AAAS) in 1967.

Cognitive barriers refer to the cognitive difficulties that the students encounter in learning science concepts. In science classrooms, specific language with a predetermined vocabulary, structure, and expository text is commonly employed. These are referred to as "literacy barriers" and can include inadequate metacognitive abilities, fluency, decoding, word recognition, verbalizing and picturing new information, and organizing new information. Reading to learn is a time-consuming task with little progress in comprehension when children lack fluency caused by these literacy barriers (Boyle et al 2020).

In Chew & Cerbin (2020), it was mentioned that mental mindset is also an example of cognitive challenges in learning. Students' attitudes, convictions, and expectations regarding a course or subject are referred to as their mental mindset. A person's mental mindset includes their ideas about their chances of succeeding in the course on their own, as well as their teacher, course, topic, methodology, and assessment technique. Students enter a class with preconceived ideas about how beneficial the course will be to them, how significant it is in relation to other courses they are enrolled in, how challenging the course will be, and what constitutes a manageable workload.

The gold standard of learning is transfer of learning, where students appropriately apply what they have learned in new circumstances. Every teacher wants their pupils to remember and apply the knowledge they have learned in class outside of the immediate classroom setting, even after the final exam is over. However, transfer is still a challenging and elusive objective to accomplish, with numerous strategies and few successes (Day & Goldstone, 2012). Even when learners perform well on tests, teachers cannot assume that their learning will be retained and transferred. There is no guarantee that once pupils grasp a subject, they will use it on their own outside of the classroom. Instructors ought to think about how to create pedagogy that encourages transfer to pertinent contexts (Agarwal & Bain, 2019).

Numerous studies have discovered that student misconceptions have an impact on students' academic performance in science topics and are directly tied to science learning. Science education misconceptions are entrenched and difficult to dispel (Laliyo et al., 2020; Park and Liu, 2019; Prodjosantoso et al., 2019; Slater et al., 2018; Wernecke et al., 2018). Students in the 8th grade commonly have misconceptions about the particle nature of matter (Nuić & Glažar, 2023), chemical bonds (Erman, 2016; and Luxford & Bretz, 2014), and equilibrium and chemical processes (Omilani & Elebute, 2020).

According to Al-Balushi et al (2012), many things can lead to misconceptions in science education, which can seriously impair students' comprehension of scientific ideas. In the ontological review of Suprapto (2020), there are five types of misconceptions: preconceived notions, non-scientific beliefs, conceptual misunderstandings, vernacular misconceptions, and factual misconceptions.

Preconceived notion(s) is a belief that is frequently derived from real-world daily experiences, both within and outside of the classroom. When a person first starts school, he will be given a scientific explanation for what he has observed in the past that is not intuitive. It is a cause of misconception in the learning process since confidence in the original conceptual understanding does not change even after the teaching and learning process is complete. According to research, students frequently carry preexisting conceptions into the classroom, which might cause misconceptions when fresh material is introduced. For example, Ürey (2018) emphasizes how the association between prior knowledge and recently acquired notions can form an inflexible mental framework that sustains misunderstandings. This is corroborated by Nikmah (2022) who discovered that a sizable portion of aspiring science instructors had misconceptions because of their insufficient comprehension of the subject matter and the impact of their prior education.

Non-scientific beliefs are beliefs that do not agree with science experts. All views that are taught to students coming from sources that differ from the opinions of professionals are considered unscientific beliefs. One approach that shows up is religious or mythical instruction that lacks scientific validation. Two theories—one that is incompatible with the idea of religion and the other that is consistent with religious beliefs—are Evolution and the Big Bang.

Conceptual misunderstandings usually occur when students relate to expert judgments in a way that prevents them from resolving conflicts or paradoxes because of presumptions about preconceived notions and non-scientific beliefs. Students feel unsatisfied at the end of their education and are unable to articulate what they have learnt. These students thus create inaccurate models that restrict the future of education.

Vernacular misconceptions result from the usage of terminology that, although meaning something to many non-experts, will signify quite different things when seen from the point of view of science. One example is the term "work" which may mean as a job in the views of non-experts in science whereas it pertains to an entirely different concept when used in science lessons.

Factual misconceptions are errors that start in childhood and don't change until adulthood. Teachers, parents, and even textbooks could be the primary source of this mistake. Numerous well-known scientists acknowledged that they were unable to assist in solving this. "All the books are there: they say something that is useless, confusing, vague, erroneous, and only partially correct," said renowned physicist and Nobel Prize winner Richard Feynman. Resources that provide inaccurate information can worsen misconceptions. Halim et al. (2018) emphasized how important is the accuracy of teaching materials to prevent misunderstandings.

In 1967, the American Association for Advancement of Science (AAAS) launched the Science-A Process Approach (SAPA) curriculum project, which popularized the idea of science process skills. Gagne's 1965 idea of science as a process led to the creation of the SAPA. According to Gagne, the concepts and principles of science can only be discovered through a variety of scientific procedures, including observation, categorization, description, communication, inference, operational definition, formulation, control, interpretation, and experimentation. SAPA separated process skills into two groups: basic and integrated (Fugarasti et al, 2019).

Basic science process skills encompass abilities such as observing, measuring, classifying, predicting, and communicating. On the other hand, integrated science process skills include controlling variables, hypothesizing, experimenting, and data interpreting. All the skills mentioned are crucial in the process of learning chemistry. This is because they enable students to engage with instructional materials and develop a deeper understanding of science concepts.

While all of the aforementioned skills are empirical to science, some of them are more likely applied in chemistry than others. These include measuring and observing controlling variables, hypothesizing, experimenting. and data interpreting. These skills prepare students for the real-world applications of chemistry in various fields and assist them in developing a deeper understanding of concepts in chemistry (Mellyzar et al., 2023; Umami et al., 2020; Harta et al., 2019; Arantika et al., 2018).

Science process skills aid in developing students' critical thinking and problem-solving skills which may lead to enhancing their academic performance. The learners' logical reasoning and research skills also develop as they practice their science process skills more frequently, both of which are essential for resolving real-world scientific problems (Wijaya et al., 2021). Irwanto (2018) also points out that if teachers focus on the learners' science process skills, their learning outcomes eventually improve. According to him, if these skills are enhanced, it can aid students in understanding chemistry concepts and prepare them for more difficult problem-solving situations that they may encounter in their academic and professional lives.

In order to more effectively develop the science process skills of learners, the learners must be engaged in laboratory works in chemistry. Hands-on chemistry activities can enhance the learners' abilities to observe, predict, interpret, and communicate scientific discoveries (Harta et al., 2019). In addition, Mellyzar et al. (2023) said that practical exercises allow students to predict chemical reactions. and explain the results by drawing on their prior knowledge. Furthernore, problem-solving and critical thinking skills are crucial for laboratory work because students usually have to adjust the approaches they use upon encountering unforeseen results or challenges during experiments. Irwanto (2018) emphasizes that in order to promote analytical thinking and science process skills among students, educators should make use of inquiry-based activities to cultivate a scientific mindset.

The study focuses on the learners' learning cognitive barriers and misconceptions in Science concepts as correlates of Science Process Skills.

The conceptual guide shows the independent variables, learning cognitive barriers and misconceptions in Chemistry. The learning cognitive barriers include literacy, mental mindset, and transfer of learning. The misconceptions in Chemistry were measured in terms of preconceived notions, non-scientific beliefs, conceptual misunderstandings, vernacular misconceptions, and factual misconceptions.

On the other hand, the dependent variable is Science Process Skills namely: observing, measuring, classifying, predicting, and communicating for basic SPS; controlling variables, hypothesizing, experimentation, and data interpreting for the integrated SPS.

Figure 1.

Research Paradigm

Independent Variables

- **I. Learning Cognitive Barriers**
  - literacy
  - mental mindset
  - transfer of learning
- **II. Misconceptions in Chemistry**
  - preconceived notions
  - non-scientific beliefs
  - conceptual misunderstandings
  - vernacular misconceptions
  - factual misconceptions

Dependent Variables

Science Process Skills:

- **I. Basic**
  - observing
  - measuring
  - classifying
  - predicting
  - communicating
- **II. Integrated**
  - controlling variables
  - hypothesizing
  - experimenting
  - data interpreting

Statement of the Problem

This study attempted to determine the learning cognitive barriers and misconceptions of Chemistry concepts and their relationship to basic and integrated science process skills of grade 8 students.

Specifically, it aimed to answer the following questions:

1. To what extent is the learning cognitive barriers experienced by the students as to:

   1.1. literacy;

   1.2. mental mindset; and

   1.3. transfer of learning?

2. What is the level of misconception of the learners in Chemistry concepts in terms of:

2.1. preconceived notions;

2.2. non-scientific beliefs;

2.3. conceptual misunderstandings;

2.4. vernacular misunderstandings; and

2.5. factual misconceptions?

3. What is the performance score of students on basic science process skills as to:

   3.1. observing;

   3.2. measuring;

   3.3. classifying;

   3.4. predicting; and

   3.5. communicating?

4. What is the performance score of integrated science process skills prevalent among the respondents as to:

4.1. controlling variables;

4.2. hypothesizing;

4.3. experimenting; and

4.4. data interpreting?

5. Is there a significant relationship between the students' learning cognitive barriers and their science process skills as to:

5.1. basic science process skills; and

5.2. integrated science process skills?

6. Is there a significant relationship between the students' misconceptions in Chemistry and their science process skills as to:

6.1. basic science process skills; and

6.2. integrated science process skills?

Hypotheses

The study posited the following hypotheses:

There is no significant relationship between the grade 8 learners' learning cognitive barriers and science process skills.

There is no significant relationship between the grade 8 learners' misconceptions about Chemistry and science process skills.

Significance of the Study

The researcher anticipates that the results of this study will benefit the following:

Students. This study may inspire learners to improve their science knowledge by addressing their learning cognitive barriers and misconceptions in Chemistry then enhance their science process skills.

Science Teachers. The findings from this study would provide valuable information to the teacher as to the necessity for their students to enhance their science process skills and eliminate misconceptions and address cognitive barriers specially in learning about Chemistry. Thus, they may be able to improve their teaching strategies to enhance the development of such factors to their learners and develop the science process skills among their students which will be beneficial to their overall performance in the subject and across other areas.

Curriculum Developers. The results could act as a reference and motivation for the curriculum development initiatives that are intended to concentrate on fostering students' acquisition of science concepts by focusing on honing the science process skills of learners and eliminating barriers and misconceptions toward the subject.

Future Researchers. The findings, conclusions, and outcomes of this study could serve as a guide for future studies that use the same topic of inquiry but involve a different group of respondents or may implore new variables.

Scope and Limitation of the Study

This study is limited on exploring the students' learning cognitive barrier and misconceptions in relation to their science process skills.The respondents of the study were the grade 8 students of Godofredo M. Tan Integrated School of Arts and Trades in San Narciso, Quezon. The research covered the period of September 2024 to May 2025.

Definition of Terms

For a better understanding of the variables of this study, the terms below are defined:

Classifying. The ability to arrange and categorize units crucial in learning science concepts, especially in laboratory works and problem-solving.

Communicating. This skill facilitates exchanging ideas through conversing. Specifically, the learners had to locate some shapes shown in the diagrams and construct simple sentences talking about the shapes' whereabouts.

Conceptual Misunderstandings. These are the unresolved questions that students may encounter regarding their science lessons.

Controlling Variables. It is the ability of the learners to manipulate variables in an experiment to observe several possible outcomes.

Data Interpreting. This means to explain the meaning of the presented data from table, graph, etc.

Experimenting. It is the act of conducting a scientific procedure to make or determine something. In this study, the learners had to determine the best setups and variables necessary in relation to a specific experiment.

Factual Misconceptions. These are childhood mistaken assumptions that persist into adulthood.

Hypothesizing. It refers to the ability of the respondents to create an "intelligent guess" about what will happen to an experiment.

Learning Cognitive Barriers. These are the cognitive difficulties experienced by students in the process of learning science concepts.

Literacy. It is the ability to identify, understand, interpret, create, communicate, compute, and use a broad range of written and printed materials.

Measuring. It is accomplished by contrasting an item with a reference standard unit.

Mental Mindset. It refers to the attitude of students, convictions, and expectations about learning Science.

Misconception about Chemistry. This pertains to the ideas with wrong interpretation of a topic in Chemistry.

Non-scientific beliefs. These are beliefs in a certain phenomenon or lesson that are not aligned with the views of science experts.

Observing. It is the most fundamental scientific ability that makes use of the five senses.

Preconceived Notions. These are the misconceptions based on the daily experiences of the learners.

Predicting. It is used to foretell what a potential future observation would be.

Science Process Skills. These are the abilities that make learning easier, engage students, foster a sense of ownership in their education, and lengthen the retention of knowledge. These are divided into two: *basic process skills* which include observing, measuring, classifying, predicting and communicating; and *integrated process skills* which consist of controlling variables, hypothesizing, experimentation and data interpreting.

Transfer of Learning. It is about how learners apply and retain the knowledge and skills they learn in class to real-life situations.

Vernacular Misconceptions. It talks about misconceptions caused by language, particularly in the definition of words.

2. REVIEW OF RELATED LITERATURE

The researcher presents literature on learning cognitive barriers, misconceptions towards science, and scientific process skills in this chapter. The purpose of the study is to investigate whether there is a connection between the variables mentioned.

Learning Cognitive Barriers

Learning cognitive barriers in relation to science process skills (SPS) refer to the mental obstacles that hinder students' ability to effectively engage in scientific inquiry and reasoning. Basri (2019), referenced by Grant (2024), mentioned that cognitive barriers are related to a lack in particular cognitive skills of learners. As an example, if a student who was not taught critical reading strategies will be tasked to read analyze a certain literature, the student may encounter difficulties in accomplishing the task. This could mean that the learner is lacking comprehension, problem-solving skills, or critical thinking methods.

Understanding the relationship between science process skills and cognitive abilities is essential. From the point of view of Irwanto et al. (2017), those learners with advanced science process skills also tend to have stronger analytical thinking skills, which are critical for scientific reasoning. Therefore, if a learner's science process skills and cognitive skills are enhanced, their learning cognitive barriers can be overcome. Additionally, the use of integrated assessment tools that can measure the cognitive and process skills of learners will give a more complete picture of students' abilities. Consequently, this whole picture can help identify specific areas where cognitive barriers might exist (Irwanto, 2018; Irwanto, 2018).

Literacy is the ability to read and write. However, a broader definition of literacy was mentioned at UNESCO's Paris Prancil expert forum. Accordingly, the ability to identify, understand, interpret, create, communicate, compute, and use a broad range of written and printed materials in a number of contexts is also a component of literacy. (Muti'ah et al, 2022; Harjono, 2018).

There are various studies that highlight how academic language becomes a significant barrier to success especially for English Language Learners (ELLs) like Filipinos. As stated by Lee and Orgill (2021), students may not be able to fully engage with difficult chemistry topics due to language barriers, which emphasizes the necessity of fair evaluation practices. Racca and Lasaten (2016) established a correlation between the academic performance of Filipino scientific students and their English language competency, contending that insufficient proficiency frequently results in systemic challenges in science courses, such as chemistry.

Science has a specific language with a predetermined vocabulary, structure, and definitions. Often, the terminologies used in the subject do not have translations to other languages. Literacy barriers include poor metacognitive skills, fluency, word recognition, decoding, verbalizing and visualizing new knowledge, and organizing new information. When learners need to read in order to learn the subject, they need to invest time for it. Their problem now is that they will struggle to comprehend the context of what they are reading if they have existing literacy barriers (Boyle et al 2020).

Scientific literacy is often overlooked as a problem in the classroom. Teachers do not give an ample amount of time to address these problems before eventually moving to their planned lessons. For instance, Rubini et al. (2019) emphasize that many teachers have difficulty understanding the concept of scientific literacy, which can have negative effects on the learning opportunities they provide in the classroom. If learners have difficulties in understanding the lessons, this may exclude students from engaging science lessons, perpetuating literacy barriers.

Moreover, language proficiency is essential to science literacy because conveying science concepts to others would be easier on the part of both the learners and teachers. When learners are literate in scientific concepts, there will be effective communication on both ends since they will be able to express their understanding and proficiently participate in science conversations (Ayik & Ayik, 2021).

Meanwhile, Llosa et al. (2016) indicate that if educators use instructional materials that encourage inquiry and engagement, they might just be able to close the gaps in science education successfully. Contextualized teaching methods may also help reduce literacy barriers for Filipino students, as demonstrated by Wiyarsi et al. (2021), who show that including socio-scientific issues into the curriculum can help mitigate literacy barriers for Filipinos.

Students' attitudes, convictions, and expectations regarding a course or subject are referred to as their mental mindset (Chew & Cerbin, 2020; Chew, 2014; Farrington, 2013) Mental mindset includes the instructor, the subject, the methodology, the evaluation technique, and the students' expectations regarding their chances of succeeding in the course on their own. For instance, even after adjusting for past knowledge, Cahill et al. (2018) discovered that student attitudes toward science predicted student learning across a variety of topics, courses, teaching philosophies, and evaluation methods.

Growth mindsets are important in academic settings, according to a meta-analysis by Sisk et al. (2018). Students that adopt this attitude are more likely to accept challenges and persevere through setbacks, which are critical qualities for acquiring science process skills. This conclusion is supported by Burnette et al. (2023), who highlight that attitude therapies may improve academic results, particularly for kids who might struggle to apply conventional teaching methods. A positive mental attitude also improves comprehension and promotes the use of past knowledge, which helps students understand the significance of variable control in scientific research (Marriott et al., 2018; Marriott et al., 2019).

In the pursuit of science education, inquiries and experiments are often accompanied by mistakes. Therefore, it is critical to view such mishaps as opportunities to grow further and learn deeper. How students perceive their own skills will reflect how they will learn even through challenging scientific concepts. To enhance students' cognitive engagement with science concepts and comprehension of complicated science systems, it is crucial to nurture the kind of mindset that seasoned researchers possess (Stella, 2021).

Nevertheless, students may still encounter hindrances to meaningful learning even with various supportive pedagogical strategies implored by educators. These obstacles could include a lack of understanding that prevents them from interacting with chemistry concepts in a meaningful way, indicating that even the best teaching strategies can be ineffective when language barriers are present. Moreover, learners often struggle to find a connection between chemistry lessons and their everyday experiences, which poses a great challenge in making sense of their learning experiences. Educators are recommended to apply innovative pedagogical approaches such as virtual laboratory simulation when actual laboratory experiments are not readily available. This way, the learning experience imparted will be more authentic and effective to get the lesson across (Bernardo et al., 2023; Mphafudi and Ramaila, 2020).

Transfer of learning is one of the most crucial parts of pursuing science education. It is observed when the learners can apply what they have learned in the classroom to real-world contexts. When students have high retention of what they have learned in class, they will be able to understand deeper science concepts and successfully make connections with what they experience to what they know based on classroom discussions. However, learning transfer does not happen all the time. It is significantly impacted by pedagogical practices used by the teacher. Inquiry-based learning piques students' curiosity and encourages them to ask relevant questions, leading to a deeper understanding and better application of scientific concepts (Ruzaman and Rosli, 2020).

Transfer of learning is significantly impacted by the pedagogical strategies employed in science education. For instance, Zarei & Rahimi (2014) note that a number of factors influence the effectiveness of knowledge transfer, including the type of knowledge and the context in which it is applied. This assertion is supported by Dopico (2017), who notes that uneven learning goals and approaches can hinder knowledge transfer in scientific courses. As emphasized by Junus (2021) and Hidayat and Subekti (2022), the emphasis on experiential, inquiry-based learning approaches further illustrates how students' active engagement in scientific processes enhances their ability to transfer knowledge effectively. These models help students explore, hypothesize, and experiment, which improves their understanding and promotes applying recently learned concepts to new situations.

Moreover, a learner's motivation and attitude towards science can have a significant impact to transfer of learning. Advances in scientific understanding is greatly backed by a learner's tenacity and positive outlook on science (Fuente, 2019). Thus, those students who are motivated to learn are more likely to display connections between what they learn in science classes and apply what they have learned to real-life situations. Nishimura et al. (2020) support this as they enumerate a few factors that affect students' attitudes toward learning, including self-efficacy and participation in science-related activities.

The learning environment has a significant impact on facilitating transfer as well. Peer pressure and social interactions have a big influence on how well children do academically in science, claims Gara (2023). By giving students the chance to engage with a range of perspectives and methods for addressing problems, fostering cooperation and information exchange in a nurturing classroom setting can aid in the transfer of knowledge. This collaborative element is further supported by the findings of Ward et al. (2020), who argue that early positive experiences in science education may cultivate a lifelong interest and willingness to learn, thereby increasing the likelihood of successful information transfer.

Students can apply previously acquired skills to new scientific challenges thanks to the integration of science process skills made easier by this learning transfer. For instance, Setiawan et al. (2020) argue that learning environments based on constructivist principles can significantly enhance science process abilities. According to their findings, students who engage in meaningful learning experiences are better equipped to apply their knowledge in a variety of situations, which improves their capacity for scientific inquiry.

Furthermore, it has been shown that inquiry-based learning models effectively facilitate learning transfer. Purwanti and Yuliani (2020) claim that students when learners solve problems, they can practice science process skills effectively as educators use guided inquiry techniques. In these cases, the learners get to apply their newly acquired skills taught by the teacher in a reinforced way by having active engagement with science concepts. The inquiry model helps in the learners’ pursuit of understanding scientific method because it encourages learners to apply what they have learned to real-world situations.

Anwar et al. (2023) offer more proof of the connection between prior knowledge and worthwhile chemistry learning experiences by arguing that students who possess a strong foundation of knowledge actively seek out extra help when they come across new ideas. However, some research shows contradictory results about how prior knowledge affects meaningful learning. Peechapol's (2021) research, for example, shows that students with less prior knowledge can occasionally perform better than their peers with more knowledge. Additionally, the study of Eitemüller and Habig (2021) shows that students with initially low prior knowledge often face challenges in implementing newly introduced concepts, which can lead to feelings of being overwhelmed and deter meaningful learning.

Misconception in Chemistry

Upon finishing high school, a learner needs to be equipped with three things: conceptual knowledge, skills, and attitude. Chemistry is one of the subjects in high school that deals with conceptual knowledge (Chan & Luo, 2021; Lofgren et al., 2020). As learners go through their daily experiences and have constant interactions with the environment, they will gain knowledge, skills, attitudes, and experiences that may aid how they learn new science concepts long before it is taught in the classroom. However, when science-related ideas are created, they frequently lead to misconceptions that persist long in a learner’s mind until such time that it is corrected (Soeharto & Csapo, 2022).

Because misconceptions often persist after formal schooling and can hinder students' ability to fully comprehend science subjects, they represent a significant barrier to successful learning in science education. Kibirige and Mamashela (2022) claim that students' misunderstandings of force hindered their ability to draw conclusions that are consistent with science. Further evidence of the persistence of misconceptions comes from Okur and Seyhan (2021), who emphasized the importance of identifying and correcting pre-existing misconceptions in educational contexts. Their study showed how argumentation-supported PBL can successfully detect and correct misconceptions held by aspiring science teachers.

Chemical bonding is a frequently misunderstood concept in chemistry among grade 8 learners. In the study of Erman (2016), students often find the concept of polarity and different types of bonds difficult to comprehend. Luxford and Bretz (2014) stated that students make common mistakes in representations of chemical bonding and misinterpret common but crucial concepts in chemistry like octet rule and electrostatic interactions. According to Adu-Gyamfi & Asaki (2022), this may have been caused by poor teaching methods or ambiguous terminology in textbooks that could not fully explain these concepts.

Furthermore, Tümay (2016) stated that the learners’ incapacity to understand the nature of chemical properties and interactions is one of the main reasons why they struggle with learning chemistry. As one of the foundational knowledge in the subject, this failure can actually lead to persistent conceptual misunderstandings in students. Thus, it will be more difficult to make connections with new information to what the learners already know about the subject. This study suggests that educators should focus on identifying specific learning demands in order to effectively address these misconceptions.

According to Chew & Cerbin (2020), preconceived notions are based on the learners' past knowledge and experiences, which may affect the chemistry learning process. They added that in order to make sense of new information, the learners need to actively apply their past knowledge regarding a topic. However, when it is their background about the topic that is incorrect, their learning will most likely lead to misunderstanding, misinterpretation, or worse, they may ignore the new information that they learn. As indicated by Adu-Gyamfi and Ampiah (2019), educators must keep in mind that the learners have preconceptions that they bring to class before lectures even start. These preconceptions may also significantly impact their learning outcomes. The authors recommend that educators should develop instructional strategies that specifically address these misconceptions in order to enhance students' comprehension of chemistry. According to Stern et al. (2018), preconceptions can lead to misconceptions about biological concepts, but they also emphasize that not all preconceptions are false and can be the foundation for new knowledge.

Misconceptions in chemistry education are largely caused by non-scientific beliefs, which include opinions that students have learned that differ from those of experts. Students often struggle with chemistry because of non-scientific beliefs that may impede their conceptual understanding of the subject (Redhana et al., 2017). The study, which looked at chemistry learning problems using a conceptual change model, discovered that students' misconceptions are frequently founded on experiences and preconceptions that contradict scientific principles. According to Adu-Gyamfi and Asaki (2022), misconceptions affect both teachers and students, and they may inadvertently spread non-scientific beliefs through their instructional strategies. The persistence of these ideas can create a vicious cycle where students and teachers continue to hold onto erroneous beliefs, which further complicates learning.

Likewise, Islamiyah et al. (2022) highlight how effective are remediation techniques in addressing misconceptions, especially those that stem from non-scientific beliefs. The authors argue that in order to enhance the level of understanding of chemistry among learners, the educators must recognize and question these presumptions. In support of this view, the findings of Seyhan and Türk (2022) leads them to highlight that in order to debunk myths in science learning, educators must work on how the learners relate scientific concepts to circumstances in the real word. They emphasize that if these non-scientific views are not addressed properly, there will be serious barriers to understanding more complex topics in the subject.

Furthermore, Sunyono et al. (2016)'s study highlights the ways in which teachers affect their students' opinions about chemistry. The study found that erroneous information provided by teachers or textbooks, which may endorse non-scientific opinions, frequently leads to misunderstandings. This highlights how crucial it is that strategies that debunk these myths and promote scientific understanding be incorporated into teacher preparation programs. Furthermore, studies by Mubarak and Yahdi (2020) demonstrate that prior knowledge—which may include non-scientific viewpoints—has a significant impact on students' performance in chemistry classes. The authors contend that clearing up these misconceptions is crucial to providing a solid foundation for innovative scientific concepts.

According to Supanto (2020), conceptual misunderstandings in chemistry education occur when students' interpretations of professional opinions deviate from accepted scientific principles. This frequently results in discontent and an inability to communicate what they have learned. It's crucial to remember that educators also carry conceptual errors from their own learning experiences, claim Adu-Gyamfi and Asaki (2022). This duality of misunderstanding can make the learning environment challenging because teachers may inadvertently promote false concepts during instruction. The authors argue that improving chemistry students' performance requires dispelling these myths.

Moradi (2023) discusses the importance of identifying and correcting student misconceptions in order to improve learning outcomes. The study found that misconceptions are closely related to the students' cognitive frameworks and hinder their ability to understand and apply new concepts. Further proof that conceptual misunderstandings are common in many scientific fields, including chemistry, is given by Karaçöp (2017). According to the study, students frequently have trouble understanding basic ideas, which can result in serious learning challenges. The work of Setiawan and Ilahi (2022), who pinpoint misconceptions about chemical bonding as a significant obstacle to students' comprehension, supports this. In order to identify these misconceptions and enable teachers to employ focused teaching techniques, the authors support the use of diagnostic tests.

Furthermore, studies indicate that traditional teaching methods that ignore students' prior knowledge may exacerbate misconceptions. Misconceptions can arise from students' misunderstandings and a lack of direction when studying independently, according to Malaterre et al. (2023). This highlights the significance of instructional strategies that actively address these misconceptions. According to Aulia (2023), misconceptions can stem from sophisticated and stable prior knowledge that is not adequately addressed during the learning process.

According to Supanto (2020), students who interpret scientific terms using everyday language may develop vernacular misconceptions in chemistry classes that could impede their learning. In chemistry classes, it is essential to use clear language (Reina et al., 2022). According to the authors, even minor changes in wording can have a significant impact on students' comprehension and ability to correctly respond to questions. This illustrates how language plays a significant role in how well students understand chemistry and how unclear terminology can result in grammatical errors. Vernacular misconceptions are also cited by Tümay (2016) as a primary cause of chemistry learning challenges.

In a study conducted by Sibomana et al. in 2021 displays how a learner’s language reinforce misconceptions about chemicals. The authors posit that students could have misunderstandings in complex topics because there are similar terminologies that have different meanings when applied to science contexts and in everyday conversations. In order to prevent the spread of slang misconceptions, this study highlights the need for teachers to provide clear explanations of key chemistry concepts and terminology.

Factual misconceptions in chemistry education are defined as enduring understanding errors that frequently start in childhood and go uncorrected into adulthood, according to Supanto's (2020) study. These misunderstandings can originate from a number of places, such as textbook content, teacher instruction, and parental influences. Muntholib et al. (2020) stress the importance of teachers understanding the fundamental concepts of chemistry. Their research indicates that students may acquire factual misunderstandings due to teachers' insufficient knowledge. This outcome is in line with research by Erman (2016), which demonstrates that students commonly acquire misconceptions as a result of learning inaccurate or inadequate information from textbooks or in-class instruction. The author emphasizes the need for precise and comprehensive teaching materials to prevent factual misconceptions from becoming ingrained.

The study by Nasrudin and Azizah (2020) highlights the value of metacognitive skills in clearing up factual misconceptions. The authors argue that by increasing their awareness of and control over their mental processes, students can identify and fix their mistakes. Students benefit more from context-based activities that allow them to apply their chemistry knowledge than from rote memorization, claim Broman et al. (2018). Küçükaydın (2019) discussed factual inaccuracies, reflecting the general agreement in science education that dispelling myths is crucial to creating accurate scientific knowledge.

Misconceptions pose as a hindrance to learners in studying science because the learners fail to form the correct ideas from the very start which can lead to complications to form higher levels of learning. Additionally, educators make assumptions about their lessons that they share to their students which can actually lead to further misconceptions (Moodley & Gaigher, 2019; Bektas, 2017).

Science Process Skills

To engage in scientific inquiry and problem-solving, students must develop science process skills (SPS). Science process skills are tools for gathering knowledge about the world. On the other hand, they are also defined as the ability to identify problems, formulate hypotheses about those problems, make accurate predictions, identify and define variables, and design experiments to test those hypotheses (Padilla, 2009, as cited in Kamba et al, 2018). In the study of Mirana (2019), it was mentioned that students will struggle to learn and may not have meaningful learning experiences if they do not develop these skills. The lack of the latter significantly adds to the waning interest in and bad attitudes about science. Hence, scientific education should support the required learning environment, including active involvement, life integration, and meaningful learning, for the development of science process skills in schools.

Students' enthusiasm and engagement are also increased when science process skills are incorporated into chemistry instruction. Apriwanda et al. (2021) discovered a substantial correlation between students' willingness to learn chemistry and their science process abilities. This suggests that active learning methodologies, such project-based learning, might greatly enhance these skills. Agus's (2022) meta-analysis, which found a strong positive link between science process abilities and cognitive learning results across a range of scientific fields, including chemistry, further supports this. Developing these abilities may result in better academic achievement and a more profound comprehension of scientific ideas, according to these studies.

Science is more than just scientific knowledge. Although SPS should not be taught as a stand-alone lesson, they should be utilized as a benchmark when organizing lessons. These abilities must be linked to crucial ideas. As a result, science knowledge supports lessons but shouldn't be the focus of them. Instead, more focus has to be placed on activities that develop science process abilities and deepen students' comprehension of scientific concepts. This suggests that process skills work hard in conjunction with scientific knowledge and attitudes to support students' systematic thinking (Riovero as cited by Coronado, 2016).

The cultivation of basic science process skills, including observing, measuring, classifying, predicting, and communicating, is vital in promoting scientific literacy and augmenting students' capacity to interact with scientific ideas proficiently. These abilities provide as the fundamental building blocks that let students do scientific investigations and comprehend the nature of scientific information.

. The ability to observe is one of the most crucial skills that students should acquire. It involves using the senses to gather information about the surroundings in order to formulate hypotheses and conduct experiments. Rinjani (2023) emphasizes the value of observation as the first science process skill that learners need to develop. He also mentioned that before students can progress to integrated skills, they must first master basic science process skills.

Basic science process skills also include measuring and classifying. As explained by Lumbantoruan et al. (2019), students must be able to quantify observations and methodically arrange information in order to analyze and interpret data. These are both essential, especially during the conduct of research and when producing reliable findings. On top of that, Kurniawan et al. (2018) pointed out that if students fail to grasp basic skills like measuring and classifying, they will inevitably find it difficult to develop more complex integrated science process skills.

Other critical abilities that support scientific inquiry include communication and prediction. Both hypothesis testing and experimental design are based on prediction, which is the process of making informed assumptions about what will occur in the future based on current knowledge. the relationship between students' ability to predict the outcomes of scientific investigations and their proficiency with the science process (Hernawati et al., 2018). On the other hand, good communication is necessary for sharing findings and collaborating with other members of the scientific community. Tyas et al. (2021) assert that effective communication of scientific concepts and findings is essential to fostering a collaborative learning environment and improving students' general scientific literacy.

Among the five basic science process skills, two are most commonly used in chemistry lessons: measuring and observing. Mellyzar et al. (2023) claim that in order to conduct experiments and produce accurate results, exact measurement is always necessary. They discussed that measuring skills can also contribute to the prediction skills of learners in chemistry activities experiments. Additionally, they argued that the observational skills of learners are equally important because students often need to identify chemicals and note even the slightest change when conducting experiments.

Enhancing students' ability to conduct scientific inquiry and fostering scientific literacy depend on their ability to develop integrated science process skills. Controlling variables, formulating hypotheses, conducting experiments, and analyzing data are all included in the category of integrated science process skills. Students need these skills in order to conduct scientific research and apply scientific thinking in practical contexts.

One essential component of scientific experimentation is variable control. Students can increase the validity of their experimental findings by separating the effects of independent variables on dependent variables. Kurniawan et al. (2019) stress that students' exceptional mastery of observation skills has a significant impact on their ability to successfully construct experiments, which is crucial for controlling variables during investigations. Furthermore, Ediyanto et al. (2018) emphasize that conducting scientific research and resolving complex problems require the ability to regulate variables and other integrated science process skills. This skill is especially important since it enables students to form scientific literacy by enabling them to form opinions based on empirical evidence (Arantika et al., 2018).

Hypothesizing is a skill that encourages creativity and critical thinking among the learners. If learners can effectively formulate hypotheses, then they will be able to make predictions testable through science activities and experiments. Nirmala and Darmawati (2021) show that to improve the science process skills of learners especially the capacity to develop hypotheses, educators must employ discovery-based laboratory learning. This is also supported by Fiolida et al. (2021), who contend learners must first understand basic science process skills to facilitate the application of integrated abilities like hypothesizing. If a learner is able to formulate hypotheses, they subconsciously develop broader understanding of science concepts among themselves and give rise to their skills in experimenting as well.

Experimenting skill in science education is about applying scientific principles to gather information and test hypotheses. As explained by Kurniawan et al. (2021), in experimenting, there is a combination of several science process skills, as it is an integrated process skill. Wardani et al. (2019) claimed that experimenting allows students to develop and broaden their science process skills. This type of experiential learning is necessary to build a strong understanding of scientific ideas and methods.

Data interpreting is the last skill that connects all of the other skills mentioned. Umami et al. (2020) highlighted that interpretation of data is one of the most important integrated science process skills that learners should master. Kurniawan et al. (2020) stated that the ability to generate tables and graphs and identify correlations between variables are essential for effective data interpretation. Having this ability is essential for learners to effectively explain their findings during science presentations in class or exhibits or contests. Additionally, if educators strive to further develop learners’ data interpretation skills, the students' overall scientific literacy and their ability to engage meaningfully with scientific data will also be enhanced (Maizaliani, 2024).

3. RESEARCH METHODOLOGY

This chapter gives an overview of the research methodology applied to this study. It describes the research design, respondents of the study, research instruments, research procedure, and statistical treatment of data.

Research Design

Using questionnaires to collect data on the current state of affairs in the area, the research study employed a descriptive correlational design. The data collected from the target learners' responses was subjected to statistical analyses in this quantitative study. Descriptive research gives a snapshot of the current state of affairs, while correlational research aims to identify relationships between variables and forecast future events based on current knowledge, according to Marpa et al. (2016).

The researcher intended to investigate the learning cognitive barriers experienced by the respondents, their misconceptions in Chemistry, and level of their basic and integrated science process skills.

Respondent of the Study

The objective of the study was to determine the learning cognitive barriers, misconceptions in Chemistry, then to relate them to the level of basic and integrated science process skills of Grade 8 students. The respondents were determined through purposive sampling method among the nine (9) sections of grade 8 students in Godofredo M. Tan Integrated School of Arts and Trades (GMTISAT) in San Narciso, Quezon. Purposive sampling, which is a non-probability sample chosen based on demographic characteristics and the study's goal, is also referred to as judgmental, selective, or subjective sampling (Crossman, 2017). Thus, the pilot section was excluded from the list to ensure heterogeneity or diverse background among the respondents. The researcher selected twenty (20) participants from each of the eight sections and gathered data from one hundred sixty (160) respondents from the population of grade 8 students in GMTISAT.

Research Instruments

The research instruments used were consist of one set of survey questionnaire on Learning Cognitive Barriers, and two sets of test questionnaires on Misconceptions in Chemistry and Science Process Skills Test. All of these underwent external validation from Science teachers and an English language teacher. Afterwards, they were pilot tested to ensure the reliability and validity of the questions. Furthermore, it was checked and internally validated by the panel of the researcher before its implementation.

The survey questionnaire on Learning Cognitive Barriers was made by the researcher composed of 24 items divided into 3 categories that determined the mean learning cognitive barriers experienced by the respondents as to literacy, mental mindset, and transfer of learning.

The test questionnaire on Misconceptions in Chemistry constructed by the researcher has a total of 35 items, with 7 questions for each type of misconception such as preconceived notions, non-scientific beliefs, conceptual misunderstandings, vernacular misconceptions, and factual misconceptions. It is divided into two parts. The first part is a multiple choices type of test composed of 10 questions. The second part is a true or false type of test with 25 items. The coverage of the test for misconceptions were the lessons in the 3rd quarter of grade 8 curriculum including particle nature of matter, phase change, atoms & molecules, and the periodic table of elements.

The last test questionnaire is about the Science Process Skills Test adapted and modified from the works of Zeidan & Jayosi (2015), Maranan (2017), Del Rosario (2023), Casiñas & Paco (2024), and Fidelino (2024). The researcher used several references in crafting the questions to carefully consider the appropriateness of the questions to the learners’ abilities. It was divided into two categories – basic and integrated.

The basic science process skills comprise of observing, measuring, classifying, predicting, and communicating. In observing, the first 3 items required them to carefully observe figures and answer questions based on their observations while in the other 2 items, they had to read the questions and determine which of the choices make use of the observational skills. For measuring, they had to identify the correct answer from the questions about measurement. For the classifying skill, they had to categorize the given units according to their use. To test for their skill in predicting, there are given situations from which they had to choose the correct prediction of what is supposed to happen after. Lastly, the communicating skill required them to write the location of the object by consulting the map. Also, they had to craft sentences describing the location of the cylinder based on the figure presented.

The integrated science process skills include controlling variables, hypothesizing, experimenting, and data interpreting. In controlling variables, they had to review the circumstances and provide responses to the questions regarding controlling variables. For hypothesizing, they had to study the situations closely and identify the best intelligent guess for each. To test their skills in experimenting, they were to examine the scenarios thoroughly and answer the subsequent questions about experimentation. Finally, the data interpreting skill required them to read the statements and analyze the data carefully to answer the questions and give conclusions based on the data table presented.

Research Procedure

There were two phases in the research procedure involved in this study. The first phase was where the researcher constructed and developed the survey and test questionnaires which was used in the study. Afterwards, she subjected those instruments for external validation. After consolidating and applying the experts’ opinion on the instruments, the researcher prepared copies and conducted pilot-testing. The results of the pilot-testing were submitted to the statistician to test their validity and reliability. Afterwards, some items were deleted and modified based on the results and the instrument was subjected for internal validation. The final form of the instruments adapted the opinion of the internal validators. Then, the researcher prepared several copies of the instruments to conduct the study.

The second phase was where researcher submitted pertinent papers to the division office of Department of Education in Quezon Province to be granted permission to conduct the study. Afterwards, she sought permission to the public schools district supervisor of San Narciso District 1 as well as to the principal of Godofredo M. Tan Integrated School of Arts and Trades to pilot-test and conducted the study in the school mentioned. She also required the help of the science 8 teachers in disseminating the research questionnaires to the randomly selected respondents among the grade 8 learners. Afterwards, she collected the questionnaires answered by the respondents. The responses were tabulated and sent to the statistics center for analysis. The researcher then interpreted each outcome based on the data obtained.

Statistical Treatment of Data

All the data gathered were collated for analysis. To quantify the data and address the study's objectives, appropriate statistical measures were applied. Afterwards, the data were tabulated and subjected to interpretation on the next chapter.

Mean was used to assess the respondents' learning cognitive barriers. Standard deviation was used to get the average of how distant the individual perceptions are from the mean. Likely, Frequency distribution was used to determine the number of respondents and the scores they attained in the test questionnaires for misconceptions in Chemistry and the science process skills.

The relationship between Learning Cognitive Barriers and Misconception towards Chemistry to Basic and Integrated Science Process Skills were examined using Pearson Correlation Coefficient (Pearson r).

4. PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

This chapter is focused on the presentation, analysis, and interpretation of data in light of the study's difficulties to provide pertinent description to ensure understanding of the gathered data.

Table 1.

Learning Cognitive Barriers Experienced by the Respondents as to Literacy

Indicators	Mean	SD	VI
I find it difficult to study Chemistry because…			
1. I can read in English but I don't fully understand it.	2.62	0.87	E
2. I know the meaning of some words in English but I cannot grasp what the whole sentence means.	2.57	0.70	E
3. it is hard to interpret chemical symbols and formulas in the lessons.	2.64	0.86	E
4. my poor English language skills affect my performance in the subject.	2.43	0.87	SE
5. we need to use English in writing laboratory reports.	2.70	0.87	E
6. there are no bilingual resources available about Chemistry.	2.42	0.87	SE
7. the language barrier hinders my ability to engage with Chemistry contents.	2.52	0.90	E
Overall	**2.56**	**0.51**	**E**

Legend: 3.50- 4.00 - Highly Experienced (HE); 2.50-3.49 – Experienced (E); 1.50- 2.49 - Slightly Experienced (SE); 1.00- 1.49 - Not Experienced (NE)

The data from table 1 reveal that the grade 8 students experienced learning cognitive barriers in terms of literacy. It is evidenced by the obtained mean of 2.56 indicating that that many students experience difficulty in comprehending science concepts using English language as the medium of instruction. In the science class of the researcher, the learners oftentimes need her to translate the lessons to Filipino for them to understand the lessons better. It was evident when the researcher was gathering this data since she had to translate some statements into Filipino for the learners to comprehend the survey questions.

However, it was shown from table 1 that the learners do not fully believe that their literacy skills affect their performance in the subject, evidenced by the obtained mean of 2.43 falling under slightly experienced category. The findings imply that learners may not recognize the role of literacy skills in influencing their understanding and performance in Chemistry.

They also do not entirely agree that the non-existence of bilingual resources is one of the reasons why they have difficulties in learning the subject, which also attained a mean falling into slightly experienced level. It can be inferred that the respondents do not believe the unavailability of bilingual materials significantly hinders their Chemistry learning.

These mean that they do not fully believe that poor literacy in English nor the language used in Chemistry books affect their performance in the subject. Arguably, there are no updated and available resources in the school for Science or Chemistry lessons for grade 8 learners. The only resources readily available to be used by Science 8 learners are the Self-Learning Modules provided by DepEd during the time of the pandemic.

These obstacles may be made worse by the intricacy of scientific terminologies in Chemistry. This viewpoint is supported by Deng and Flynn (2023), who discovered that many students—including those who speak English as a second language—have a difficult time understanding scientific discourse, which has a detrimental effect on their chemistry learning outcomes.

Table 2. *Learning Cognitive Barriers Experienced by the Respondents as to Mental Mindset*

Indicators	Mean	SD	VI
I believe that…			
1. if I give enough effort, I will be able to understand Chemistry lessons.	2.89	0.97	E/BSE
2. when there are concepts in the subject that I do not fully understand, I could always seek help from peers or my teacher for clarification.	2.89	0.95	E/BSE
3. it is important that I am open to criticism as I receive feedback on my Chemistry assignments so that I can maximize my learning in the subject.	2.84	0.83	E/BSE
4. I can master challenging concepts in Chemistry when I set my mind to it.	2.64	0.88	E/BSE
5. I need to reflect on myself when I face difficulties as I study Chemistry to be able to understand the concepts better.	2.79	0.84	E/BSE
6. if I equip myself with positive mindset, it can lead to better academic outcomes in the subject.	2.91	0.91	E/BSE
7. I need to set specific and achievable goals to aid my Chemistry learning.	2.83	0.91	E/BSE
8. I possess the ability to overcome challenges in the subject.	2.71	0.83	E/BSE
9. even if I fail to accomplish a task, I can try to pursue a different method.	2.61	0.86	E/BSE
10. it is okay for me to make mistakes during performance tasks because I can always try again until I succeed.	3.02	0.95	E/BSE
Overall	**2.81**	**0.55**	**E/BSE**

Legend: 3.50- 4.00 - Highly Experienced / Barrier is Not Experienced (HE/BNE); 2.50-3.49 – Experienced / Barrier is Slightly Experienced (E/BSE); 1.50- 2.49 - Slightly Experienced / Barrier is Experienced (SE/BE); 1.00- 1.49 - Not Experienced / Barrier is Highly Experienced (NE/BHE)

Table 2 from above shows that respondents perceived that their mental mindset is not a significant learning cognitive barrier for them. The mean score of 2.81 means that they experience positive results in studying Chemistry concepts when they give enough effort, ask for feedback from peers and teachers, equip themselves with positive mindset, and reflect on their own learning. This suggests that a positive mental framework can encourage students to engage with complex scientific material rather than shy away from it due to perceived difficulties. This resilience implies that mindset may serve as a motivational rather than a cognitive barrier, allowing students to overcome challenges rather than preventing access to understanding. Thus, it can be interpreted that for the respondents, mental mindset as a barrier is slightly experienced only.

It can be shown from the table that the statement that garnered the highest mean is number 10, saying it is okay for them to make mistakes during their performance tasks since they believe that they can always try again. This is evidently shown whenever there are science activities and performance tasks where they are very eager and committed to learn and apply their knowledge in practice. In support of this, Othman et al. (2022) highlight that meaningful learning experiences are linked with the commitment and effort of students.

Table 3.

Learning Cognitive Barriers Experienced by the Respondents as to Transfer of Learning

Indicators	Mean	SD	VI
I think that…			

1. what I have learned from my previous lessons during my 7th grade in Chemistry contributes to my understanding of the current lessons in the same subject.	2.67	0.80	E/BSE
2. it is necessary to receive feedback from my Chemistry teacher in helping me understand and ensure retention of learning in the subject.	2.99	0.81	E/BSE
3. I should work on developing strategies to help me learn concepts in the subject better.	2.83	0.86	E/BSE
4. when I collaborate with my peers, I understand the lessons better.	2.82	0.89	E/BSE
5. hands-on laboratory experiences are important for transferring theoretical knowledge to practical applications in Chemistry.	2.59	0.78	E/BSE
6. it is important to connect new concepts I learn in the subject to real-life situations.	2.84	0.83	E/BSE
7. it is easy to relate to the new lessons in Chemistry when I can grasp its connection to my prior knowledge.	2.66	0.87	E/BSE
Overall	**2.77**	**0.52**	**E/BSE**

Legend: 3.50- 4.00 - Highly Experienced / Barrier is Not Experienced (HE/BNE); 2.50-3.49 – Experienced / Barrier is Slightly Experienced (E/BSE); 1.50- 2.49 - Slightly Experienced / Barrier is Experienced (SE/BE); 1.00- 1.49 - Not Experienced / Barrier is Highly Experienced (NE/BHE)

The data obtained from table 3 indicate that the students believe that transfer of learning is also not a significant learning cognitive barrier in the pursuit of Chemistry learning. Based on their experience, the learners agree that when they receive feedback, develop own strategies, collaborate with peers, utilize hands-on laboratory experience, and connect prior knowledge and real-life situations, they gain better understanding of lessons in Chemistry 8, as shown by the obtained mean of 2.77.

Thus, it can be stipulated that transfer of learning is not a cognitive barrier because instead of impeding understanding, it acts as a facilitator, promoting deeper comprehension and application of scientific concepts across various scenarios. This suggests that students' abilities to move knowledge between domains are not limited and that they can build connections from their prior knowledge that enhance learning in science. Similar to the findings for mental mindset, transfer of learning as a barrier is also only slightly experienced by the respondents.

Consequently, they think that they should find connection of new learning that they acquire to their previous knowledge about it as well as the real-life situations that they encounter daily. An essential similar finding about this was presented by Fitriyana et al. (2021), emphasizing that students with higher prior knowledge are more likely to effectively integrate new information.

Table 4.

Distribution of Respondents' Misconceptions in Chemistry

Score	Preconceived Notions		Non-Scientific Beliefs		Conceptual Misunderstand-ings		Vernacular Misconceptions		Factual Misconceptions		VI
	f	**%**	***f***	**%**	***f***	**%**	***f***	**%**	***f***	**%**	
7	0	0.00	3	1.88	0	0.00	1	0.63	0	0.00	NM
5-6	5	3.13	9	5.63	28	17.50	40	25.00	9	5.63	LM
3-4	29	18.13	89	55.63	77	48.13	90	56.25	54	33.75	MM
1-2	107	66.88	56	35.00	55	34.38	27	16.88	79	49.38	HM
0	19	11.88	3	1.88	0	0.00	2	1.25	18	11.25	VHM
TOTAL	**160**	**100**	**160**	**100**	**160**	**100**	**160**	**100**	**160**	**100**	

Legend: 7 – No Misconception (NM); 5-6 – Low Misconception (LM); 3-4 – Moderate Misconception (MM); 1-2 – High Misconception (HM); 0 – Very High Misconception (VHM)

Table 4 presents that most of the respondents have high misconception in terms of preconceived notions and factual misconceptions. Preconceived notions are the prior knowledge based on personal experiences that students have before encountering new lessons. This may have stemmed from the varied background and experiences which were difficult to dispel during the discussion.

For instance, question number 8 from the test for misconception which garnered the lowest number of correct answers from the respondents – only 18 out of 160 were right. It asks what happens to the arrangement of particles in a mothball once it is placed inside the cabinet for a month. The correct answer was that the particles are getting farther apart as they turn to gaseous state but most of them responded that the mothballs melted or pests like cockroaches consume them over time. Thus, the learners have differences in their personal experiences which may have contributed to their high misconception.

Misconceptions may arise from students' previous experiences and knowledge, which can differ from scientific understandings. Studies of Islamiyah et al. (2022) and Setiawan & Ilahi (2022) indicate that students frequently enter chemistry classrooms with erroneous beliefs about fundamental concepts, undermining their ability to grasp new material effectively. Many students struggle to relate new concepts to everyday experiences due to chemistry's abstract principles, which can lead to misconceptions when they attempt to rationalize these ideas without adequate foundational knowledge.

Meanwhile, factual misconceptions pertain to inaccurate understandings of specific scientific facts or occurrences. These misconceptions are generally established in a student's knowledge of the subject and can be particularly difficult to overcome when they are deeply ingrained.

As an example question from number 10 item with the lowest correct responses about factual misconceptions, it asks the respondents about what happens to an atom when it becomes positive. Most of the respondents chose the letter A option that indicates it gained a positively charged particle known as proton when in fact, the correct answer is that it lost a negatively charged particle known as electron. This implies that although there is understanding about the topic since it is true that proton has a positive charge, some parts of the lessons may have left questions in the minds of the learners which were not tackled in class directly because in general, only the electrons can be lost or gained for an element to possess charge.

Table 5.

Distribution of Respondents' Performance Score on Basic Science Process Skills

Score	Observing		Measuring		Classifying		Predicting		Communicating		VI
	f	%	*f*	%	*f*	%	*f*	%	*f*	%	
5	8	5.00	16	10.00	71	44.38	19	11.88	30	18.75	O
4	19	11.88	28	17.50	12	7.50	33	20.63	20	12.50	VS
3	12	7.50	54	33.75	28	17.50	57	35.63	29	18.13	S
2	31	19.38	30	18.75	25	15.63	25	15.63	40	25.00	FS
1	52	32.50	25	15.63	12	7.50	16	10.00	8	5.00	P
0	38	23.75	7	4.38	12	7.50	10	6.25	33	20.63	DNME
TOTAL	**160**	**100**	**160**	**100**	**160**	**100**	**160**	**100**	**160**	**100**	

Legend: 5 – Outstanding (O); 4 – Very Satisfactory (VS); 3 – Satisfactory (S); 2 – Fairly Satisfactory (FS); 1 – Poor (P); 0 – Did Not Meet Expectations (DNME)

On table 5, the frequency distribution of performance scores on basic science process skills is displayed. On the table, it can be clearly seen that the *observing* skills were predominantly rated as poor. Before conducting any experiment or activity in class, the researcher often asks for the observation of learners first. She reminds them that it is always empirical to observe first. Most of the time, only the learners who perform average and above average give accurate observations while majority of the class do not participate when a teacher posits a question. This is quite alarming because we can say that it is the prerequisite process skill in science for the learners to do the other basic skills and the integrated skills. According to Maranan (2017), the development of the other science process skills depends on the ability to observe, and the outcome may suggest that students' proficiency in observing has a significant impact on their proficiency in other process skills.

The data showed that 33.75% and 35.63% of respondents achieved a satisfactory level of *measuring* and *predicting* respectively. Thus, students may find it somehow difficult to answer questions that require answers related to numbers and giving forecast based on a given situation. In the test for measuring, they had to convert commonly units required in activities and identify units and names of instruments used in a specific object being measured. Most of the respondents got scores from satisfactory up to outstanding in both skills but there are still a number of respondents who got low scores. These results emphasize the need for enhanced instructional approaches to foster these essential skills (Ediyanto et al., 2018; Widyaningsih et al., 2020). Meanwhile, the study's findings on predicting skill is similar to Manozon (2021) and implies that most students are able to analyze a collection of observations and go beyond the facts.

On *classifying* skill, majority of the learners reached outstanding level. It can be deduced that the students have mastery in answering analysis and grouping tasks. This is because from the test, they were supposed to analyze units and categorize them into what specific category they belong to. In chemistry activities, the units are utilized especially when there are measurements of ingredients and objects necessary to generate a desired result. This may have contributed to the high level of classifying skill among the learners.

The table also shows that the *communicating* skills reflected a significant need for improvement, as evidenced by only 25% of the participants rating as fairly satisfactory. In this specific part of the test, the learners had to locate two objects then describe the location of a cylinder in a sentence.

This is parallel to the findings of Manozon (2021). Being able to communicate any scientific findings is very crucial in the modern world. Thus, this result can be taken as a call for educators to focus on improving learners' communication skills.

Table 6.

Distribution of Respondents' Performance Score on Integrated Science Process Skills

Score	**Controlling Variables**		**Hypothesizing**		**Experimenting**		**Data Interpreting**		**VI**
	f	**%**	***f***	**%**	***f***	**%**	***f***	**%**	
5	8	5.00	13	8.13	9	5.63	14	8.75	O
4	18	11.25	11	6.88	26	16.25	14	8.75	VS
3	19	11.88	28	17.50	38	23.75	16	10.00	S
2	36	22.50	51	31.88	35	21.88	37	23.13	FS
1	51	31.88	30	18.75	37	23.13	48	30.00	P
0	28	17.50	27	16.88	15	9.38	31	19.38	DNME
TOTAL	**160**	**100**	**160**	**100**	**160**	**100**	**160**	**100**	

Legend: 5 – Outstanding (O); 4 – Very Satisfactory (VS); 3 – Satisfactory (S); 2 – Fairly Satisfactory (FS); 1 – Poor (P); 0 – Did Not Meet Expectations (DNME)

As seen on table 6, the frequency distribution of 160 respondents' scores on the integrated process skill is exhibited. In this result, majority or 31.88% of the respondents reached the poor level on *controlling variables.* This shows that the respondents have a clear gap in their ability to manipulate experimental conditions effectively. During class activities, the learners require extra guidance from the teacher when manipulating variables even with clear instructions already provided for them. Some factors may have caused this which the researcher was trying to look for in this paper.

The hypothesizing skill showed that majority of the respondents achieved the fairly satisfactory level. This may mean that many participants struggle with formulating testable hypotheses. In constructing laboratory reports, the researcher often asks her students to make a hypothesis based on the experiment procedure given before conducting it. They make assumptions but cannot fully provide an explanation as to how they came up with their guess. Only some learners can provide scientific reasons as evidenced by the low number of respondents achieving very satisfactory and outstanding level of the skill. According to Lacorte (2021), hypothesizing is an "intrinsic and mental process rather than a more straightforward and obvious behavior." Thus, it can be inferred that hypothesizing skill relies on the way the learners think based on what they already know in relation to the topic.

On table 6, it is displayed that the skills in *experimenting* that the majority of respondents attained a satisfactory level. In Science, experimenting is when students gather data and test their hypotheses guided by simple and direct instructions. Getting a sufficient average on this skill means that the learners can functionally comprehend and conduct experiments with adequate data quality and interpretation of results. It can be deduced that the learners have a basic understanding of steps to take to conduct an experiment based on a testable hypothesis. This is because from the questionnaire, the learners identified which setups would work best given a hypothesis.

The level of *data interpreting* skill of the respondents is labeled poor. This may have been caused by the apparent low level of basic process skills among the respondents as shown from the previous tables. To test their interpretation skills, there are data tables and a figure on the questionnaire that the learners had to analyze. They were asked to deduce and give conclusions correctly based on the data that they can observe. It was quite alarming but not surprising that they only scored poor on average. In the study of Lacorte (2021), it was mentioned that data interpreting requires the application of other basic science process skills. Thus, the data cannot be interpreted accurately if they have a clear gap in basic process skills.

Table 7.

Correlation between Learning Cognitive Barriers and Basic Science Process Skills

Basic Science Process Skills	Learning Cognitive Barriers				
	Literacy	Mental Mindset		Transfer of Learning	
Observing	-0.011	0.309	***	0.398	***
Measuring	-0.062	0.180	*	0.154	

Basic Science Process Skills	Learning Cognitive Barriers				
	Literacy	Mental Mindset		Transfer of Learning	
Classifying	-0.045	0.143		0.191	*
Predicting	-0.078	0.080		0.128	
Communicating	0.067	0.210	**	0.307	***

Legend: *. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

***. Correlation is significant at the 0.001 level (2-tailed).

Table 7 presents the correlation between the Learning Cognitive Barriers and the Basic Science Process Skills. Mental mindset is significantly related to the skills *observing*, *measuring*, and *communicating*. It can be implied that the way the respondents think of themselves correlates to their observation, measurement, and communication skills. It is observable during classroom activities that learners with more positive mindset are more likely able to make accurate observations, determine precise measurements, and convey results effectively.

Observing, classifying, and *communicating* have significant correlation to transfer of learning. This implies that the connection of transfer of learning to the three skills reflects the importance of integrating previously acquired knowledge to discern, categorize, and disseminate new information effectively. For instance, a learner equipped with correct prior knowledge regarding a specific topic being discussed in class will most likely make accurate observations, classifications, and convey correct information whereas those without existing background information on the topic may struggle to make correct implications.

Nguyễn (2021) reveals that when prior knowledge is utilized, students are better equipped to analyze and organize information into categories, leading to improved classification skills. Evidence also shows that students who draw upon their previous learning experiences are more likely to enhance their communication skills, particularly in articulating scientific concepts (Mahapatra & Bhuyan, 2023).

Overall, the learning cognitive barriers only partially correlate to the basic science process skills of the learners. Mental mindset correlates to *observing*, *measuring*, and *communicating* whereas transfer of learning correlates to *observing, classifying,* and *communicating.*

Meanwhile, the study found out that literacy does not correlate to any basic science process skill. This indicates that higher literacy levels may not automatically translate into improved science process skills or vice versa. Redhana et al. (2017) discuss how misconceptions rooted in the learning process can pose challenges for students learning chemistry, rather than merely reflecting language or literacy deficits. This emphasizes the need for instructional approaches that go beyond literacy improvement and specifically target the development of science process skills through hands-on, inquiry-based learning experiences that engage students in active experimentation.

Moreover, it was revealed that the skill *predicting* is not significantly related to any learning cognitive barrier. It suggests that students may lack a clear understanding of how to apply predictive skills in different contexts, potentially leading to difficulties in mastering complex chemistry concepts. This disconnect poses the risk of students developing a mechanical understanding of chemical concepts without being able to transfer their knowledge effectively outside of the classroom setting.

Table 8.

Correlation between Learning Cognitive Barriers and Integrated Science Process Skills

Integrated Science Process Skills	Learning Cognitive Barriers					
	Literacy		Mental Mindset		Transfer of Learning	
Controlling variables	0.255	**	0.213	**	0.264	***
Hypothesizing	0.060		0.204	**	0.198	*
Experimenting	0.163	*	0.129		0.252	**
Data Interpreting	0.216	**	0.306	***	0.385	***

Legend: *. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

***. Correlation is significant at the 0.001 level (2-tailed).

The data shown from table 8 indicates the correlation between learning cognitive barriers and integrated science process skills. It can be observed that there is a significant relationship between the barriers and the skills. The only exceptions for this are: the literacy barrier to *hypothesizing;* and mental mindset barrier to *experimenting* skill.

It is shown that *controlling variables* and *data interpreting* are significantly related to all three learning cognitive barriers. It can be inferred that the ability to control variables and interpret data effectively requires prior knowledge, a positive mindset, and literacy skills. The researcher can attest to these findings because when she prepares activities for the learners, she often hands out activity sheets with specific instructions and procedures that learners should follow.

Still, the students often make mistakes in following instructions especially when they are going to manipulate some variables in the activity and even rely on the teacher to translate the instructions to Filipino for them to follow the procedure properly. This is also true when she displays a table with data followed by questions to answer. All of the instructions are there as well as the needed data but they still find it difficult to extract the answer from the given data. The studies of Sabrina et al. (2021) and Ediyanto et al. (2018) indicate that students who face challenges in literacy often struggle to comprehend scientific texts, which can impair their ability to identify and control variables in experiments. Studies of Arantika et al. (2018), Pohan et al. (2020), and Fiolida et al. (2021) confirm that students with a growth mindset and proficiency in scientific literacy can interpret data more accurately, leading to improved scientific reasoning and understanding.

Hypothesizing is significant to both the mental mindset and transfer of learning. It can be concluded that for a student to effectively make hypothesis, they must first have a background about the concept and make an effort while being equipped with confidence in one's abilities. Even during class recitations, only the learners with prior knowledge and positive overall mindset get to make acceptable hypotheses on a given prompt. The research of Marriott et al. (2018) and Marriott et al. (2019) show that students who have prior knowledge and have a high effort-oriented mindset are more likely to engage in the hypothesizing process, fostering confidence in their cognitive abilities.

Literacy and transfer of learning have significant relationships to *experimenting*. A solid foundation of prior knowledge enables students to better grasp experimental procedures and comprehend the literacy skills required to effectively conduct experiments. Experiments tend to have specific instructions and terminologies. Therefore, the learners with low levels of literacy and retention of learning often struggle to conduct experiments in the classroom. This is evident in class activities wherein most of the time, the researcher roams around not just to facilitate but to guide learners on what to do in a step-by-step manner even though the instructions are readily available from the activity sheets provided.

Finally, integrated science process skills are closely related to cognitive barriers such as literacy barriers, mental mindset, and transfer of learning. Addressing these barriers has been shown to facilitate the development of integrated science process skills, allowing students to engage more deeply with scientific concepts and methodologies (Ediyanto et al., 2018; Sulistri, 2019). Research supports that mastering these integrated skills leads to enhanced scientific competencies, emphasizing the importance of overcoming cognitive barriers in effective science education (Susanti et al., 2021; Sulistri, 2019).

Table 9.

Correlation between Misconceptions in Chemistry and Basic Science Process Skills

Basic Science Process Skills	Misconceptions in Chemistry				
	Preconceived Notions	Non-Scientific Beliefs	Conceptual Misunderstandings	Vernacular Misconceptions	Factual Misconceptions
Observing	-0.031	0.197 *	0.118	0.015	-0.034
Measuring	0.093	0.121	0.151	0.156 *	0.057
Classifying	-0.041	0.146	0.224 **	-0.044	0.089
Predicting	0.077	-0.015	0.275 ***	0.169 *	0.148
Communicating	0.157 *	0.179 *	0.178 *	0.047	0.068

Legend: *. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

***. Correlation is significant at the 0.001 level (2-tailed).

Table 9 reveals the correlation of learners' Misconceptions in Chemistry to the Basic Science Process Skills. It was displayed from the table that preconceived notions correlated with *communicating* skill among the respondents. Therefore, the way they convey their thoughts is influenced by their daily experiences. This is noticeable during group reports after activities. They often express themselves by relating and applying what they have learned to their experiences in their lives.

According to the data, the connection between non-scientific beliefs to the basic science process skills *observing* and *communicating* is significant. Such beliefs can distort how learners interpret observations in scientific contexts and communicate what they have learned. An example of non-scientific beliefs is that there are only four elements in the universe – Earth, water, fire, and air from item number 31. This question had the lowest correct responses from this category of misconceptions which means that most of the respondents thought this was true. If this were the case, the learners will have a difficult time to observe and communicate scientifically since their beliefs do not conform to modern science.

Students with non-scientific beliefs frequently struggle to accurately observe and document scientific phenomena, which can result in misconceptions that impair their observational and communication skills, according to research by Sholahuddın et al. (2020). Additionally, it can be inferred that if learners possess non-scientific beliefs, the observational abilities of learners and their readiness to apply the scientific method would be negatively affected.

Conceptual misunderstandings have a significant relationship with the skills *classifying, predicting,* and *communicating.* Conceptual misunderstandings are the types of misconceptions that learners possess if they have questions, and they were not able to clarify them during discussions. From this study, it was evident that it had an effect in the learners' science process skills. From the test, the learners had to classify some units and put them in the correct category. For example, meter is supposedly categorized in length and kilogram is for the mass. To test their prediction skills, there were prompts for the respondents to read and analyze, then they had to come up with the best possible scenario that should follow. Lastly, in communicating, they were asked to convey the location of a certain object on the picture. Apparently, all of those skills were related with the conceptual misunderstandings of a learner. This is supported by the studies of Utami et al. (2017) and Ismail & Matore (2024) which show that students struggle to classify scientific concepts correctly when they have not fully grasped foundational principles.

Based on the findings, vernacular misconceptions are closely related to the skills *measuring* and *predicting*. Naturally, if a learner mixes common terms with scientific terminologies, they tend to get confused and may misuse measurement and prediction methods Thus, in order to effectively improve prediction and measurement capabilities, educators must work on how to eliminate these misconceptions. The study by Adu-Gyamfi & Ampiah (2019) provided support for this, arguing that interpretations of scientific terms and variations in regional languages may lead to measurement task errors.

The results show that basic science process skills like observing, measuring, classifying, predicting, and communicating are significantly correlated with chemistry misconceptions. Therefore, it can be concluded that when learners have misconceptions, it can hinder the students' abilities to use these process skills, which can ultimately cause problems for them when learning science. Teachers can also create plans to dispel misconceptions and enhance students' understanding of fundamental science process skills by recognizing these linkages. (Uriyah et al., 2023; Meganita et al., 2022).

Table 10.

Correlation between Misconceptions in Chemistry and Integrated Science Process Skills

Integrated Science Process Skills	Misconceptions in Chemistry									
	Preconceived Notions		Non-Scientific Beliefs		Conceptual Misunderstandings		Vernacular Misconceptions		Factual Misconceptions	
Controlling Variables	0.112		0.057		0.110		0.022		-0.086	
Hypothesizing	0.078		0.187	*	0.161	*	0.083		0.249	**
Experimenting	-0.024		0.025		0.065		0.099		0.077	
Data Interpreting	0.181	*	0.011		-0.026		-0.094		-0.022	

Legend: *. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

***. Correlation is significant at the 0.001 level (2-tailed).

In table 10, the correlation between eighth-grade students' Misconceptions in Chemistry and Integrated Science Process Skills is exhibited. It points that non-scientific beliefs, conceptual misunderstandings, and factual misconceptions are correlated to the *hypothesizin*g skill. It can be inferred that if a learner has strong faith on non-scientific beliefs, have unresolved questions regarding a scientific topic, and inaccurate knowledge in chemistry concepts, their ability to hypothesize is impaired. This is apparent when students construct science laboratory reports after activities. Although there are times when they make correct hypotheses, most of the time, they incorrectly guess the possible outcomes of a specific activity. The varied non-scientific beliefs that each learner has due to the differences in the setting they came from may have caused this instance. Their prior knowledge of the subject may have contributed as well. According to Adu-Gyamfi & Ampiah (2019), the presence of misconceptions often clouds students' ability to formulate accurate, testable hypotheses based on existing scientific knowledge.

The table also shows that *data interpreting* is significantly related to preconceived notions. Again, if learners come from different sitios and barangays of San Narciso, it is guaranteed that the living conditions greatly differ from those other learners. Since they differ in their daily encounters, they may have different interpretations about a given data. Hence, it can be inferred that what students experience on a daily basis can definitely affect how they expound a given set of data. These notions can shape how students understand and analyze data (Gunawan et al., 2019).

However, it can be noted that vernacular misconceptions do not correlate with any of the integrated science process skills. The findings suggest that vernacular misconceptions do not inhibit learners from developing an accurate understanding of scientific terminology and concepts. Therefore, the learners most likely understand the difference in the definition of a term when used in everyday communication and when used in science contexts.

In conclusion, among the integrated science process skills, only *hypothesizing* and *data interpreting* show significant relationships to misconceptions in chemistry. This can mean that when a learner has misconceptions in chemistry, the student's strategy of approaching problems [illegible] conclusions from given data may both be obstructed. Furthermore, if learners encounter flawed explanations or graphical representations, the [illegible] ation of data will be compromised as well.

5. SUMMARY, CONCLUSION AND RECOMMENDATION

The summary, conclusions, and associated recommendations based on the study's findings are presented in this chapter.

Summary of Findings

The study revealed the following findings:

1. In the survey of learning cognitive barriers experienced by the learners, it was discovered that they experienced literacy as a barrier. Meanwhile, both the mental mindset and transfer of learning are slightly experienced.
2. In the test of misconception, it was found out that the learners have high misconception in terms of preconceived notions and factual misconceptions. On the other hand, they have moderate misconception in terms of non-scientific beliefs, conceptual misunderstandings, and vernacular misconceptions.
3. In the result of basic science process skills test, it was revealed that the learners have poor performance score in *observing* skill, satisfactory in *measuring* and *predicting,* outstanding in *classifying,* and fairly satisfactory in *communicating* skill.
4. In the result of integrated science process skills test, it was determined that the learners have poor performance score in *controlling variables*, fairly satisfactory in *hypothesizing* and *data interpreting*, and satisfactory in *experimenting.*
5. In the correlation test of basic science process skills to learning cognitive barriers, it was ascertained that mental mindset correlates to *observing*, *measuring*, and *communicating* whereas transfer of learning correlates to *observing*, *classifying*, and *communicating.* Meanwhile, literacy does not correlate to any basic process skill and the skill *predicting* is not significantly related to any barrier. In the correlation of integrated science process skills to learning cognitive barriers, it was found out that there is a significant relationship between the barriers and the skills. The only exceptions for this are: the literacy barrier to *hypothesizing*; and mental mindset barrier to *experimenting* skill.
6. In the correlation test of basic science process skills to misconceptions in Chemistry, it was revealed that: preconceived notions correlates to *communicating* skills; non-scientific beliefs correlates to *observing* and *communicating;* conceptual misunderstandings correlates to *classifying, predicting* and *communicating;* and vernacular misunderstandings correlates to *measuring*, and *predicting.* In the correlation of integrated science process skills to misconceptions in Chemistry, it was discovered that *hypothesizing* skill is significantly related to non-scientific beliefs, conceptual misunderstandings, and factual misconceptions. It was also revealed that *data interpreting* skill is correlated with preconceived notions.

Conclusion

The findings of the study led to the formulation of the following conclusion:

The null hypothesis stating that there is no significant relationship between learning cognitive barriers and science process skills is partially sustained.

The second null hypothesis stating that there is no significant relationship between misconceptions about Chemistry and science process skills is partially not supported.

Recommendations

The researcher has come to the following conclusions and recommendations based on the results and analysis presented:

1. Since the students experienced literacy as a barrier, the teachers may consider integrating strategies to improve the literacy skills of the students in science classes. Using games as a way to improve their literacy skills may be an effective tool to address the problem. An "exit pass" before the end of the period may also help add to their vocabularies, one word at a time.

2. Science teachers are advised to clarify misconceptions in Chemistry by integrating them into the lessons and giving an ample amount of time after each discussion to answer queries from the learners. This way, such misconceptions can be addressed properly and prevent further misconceptions. Also, it may be considered that they remind the learners to always fact check their knowledge in the subject using reliable sources only.

3. Teachers may consider using strategies and techniques in class that could improve the literacy skills, mental mindset, and transfer of learning through games, inspirational videos, simulations, etc. so as to improve the basic and integrated science process skills of the learners.

4. The researcher recommends intervention and enhancement programs focused on lessening the misconceptions of the learners in Chemistry since its existence somehow relates to the science process skills of the learners.

5. In order to improve Science education where the students will benefit, additional research on the same area of focus is recommended with different approaches and respondents. Also, the process of gathering data should be improved.

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