The Effectiveness of Science Investigatory Project on Students' Science Process Skills

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ABSTRACT

The present study aimed to determine the effectiveness of Science Investigatory Project towards Science Process Skills of the Grade 12 Science, Technology, Engineering, and Mathematics students in a private-higher educational institution located at San Jose, Plaridel, Bulacan, Philippines. The researcher employed the Descriptive Ex Post Facto and one-group pre-test and post-test design to conduct the study. Using the Input-Process-Output System, the phases or stages were carried out to culminate this study. In the beginning, the researcher developed and validated the SIP Instruction Plan with the aid of the validators. Then, the researcher administered the Pre-test to gauge the Science Process Skills of the 243 Grade 12 STEM students. Afterwards, the researcher implemented the validated SIP Instruction to the Class Program for the entire semester in their Science Class. Lastly, the researcher administered the Post-test for Science Process Skills to observe the differences in Science Process Skills before and after the implementation of the SIP Instruction. For the data analysis, the researcher subjected the Pre-test and Post-test for inferential analysis using t-test for paired samples. The findings of the study revealed that students' Science Process Skills before the implementation of the SIP Instruction were poor. Interpreting Data Skill received the lowest mean score of 1.35 which means low proficient. However, the students' Science Process Skills increased after the implementation of the SIP Instruction. Synthesizing Skill received the highest mean score of 4.81 which means Highly Proficient. Hence, the study demonstrated that there was a significant effect in the Science Process Skills of the STEM students after the implementation of SIP Instruction.

Keywords: Science Process Skills, Science Investigatory Project, Science, Technology, Engineering, and Mathematics

INTRODUCTION

Science education helps students learn important concepts and facts that are related to everyday life including important skills such as: process skills, critical thinking skills, and life skills that are needed in coping up with daily life activities (Serafica et al., 2019). Basically, in learning science, students must be transformed as inquirers, scientifically literate, caring, and responsible individuals who will think critically and creatively when solving problems and making decisions about aspects affecting their personal, social, and natural environments.

In line with that, science aims to develop a healthy dose of science process skills. According to Yuliskurniawati et al. (2019), Science Process Skills involve cognitive and investigation skills as well as an understanding of methods and procedures to perform a scientific study. These skills should be applied to collect knowledge, conduct an experiment, write field notes, analyze data, and interpret research results. Examples of Science Process Skills are observing, classifying, communicating, measuring, inferring, and predicting. These skills are relevant since they will help students to become competent and confident in accessing and applying scientific information in real-life.

However, there are challenges and problems that threaten the improvement of Science Process Skills in various levels of education especially during pandemic. Manes et al. (2022) revealed that problems faced by the teachers in teaching science process skills in the blended learning to Junior High School students among Private Schools of Olongapo City are the lack of teaching materials. It also discussed that experimentation is not well emphasized

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even in the utilization of technology. As a result, the acquisition of Science Process Skills was minimal in the distance learning compared to face-to-face learning instruction. Consequently, teachers, administrators, and curriculum developers must reflect on the current teaching practices, environment, and strategies to address these issues.

This assessment only showed that after years of immersion in our science education, students have not developed their science process skills or capacities expected at their levels. It is important to improve these skills because students are no longer just tested on surface-level information. Instead, they are now tasked to solve problems, to find solutions, and to engage in critical thinking because this is now the global standard.

Moreover, Bete (2020) concluded that Science Process Skills can be developed through experimental activities in the school laboratory or classroom. The study also highlighted that Science Process Skills are one of the 21st century skills and teaching Science that involved inquiry-based application can improved these skills.

Likewise, Chongo et al. (2021) affirm that Science Process Skills are crucial. Hence, there is a need for educators to embed hands-on activities in teaching science to promote these skills.

Therefore, the researcher firmly believes that Science education requires more than just fact-based knowledge approach in teaching it. With that, Science education becomes meaningless and incomprehensible for learners if they are unable to relate and execute the discussed concepts or lesson. This gave interest to the researcher to fill the gap concerning the low Science Process Skills of students through Science Investigatory Projects – these are authentic tasks and application of science concepts to students' lives.

Statement of the Problem

This study aims to determine the influence of Science Investigatory Project on Science Process Skills of Grade 12 Science, Technology, Engineering and Mathematics (STEM) students. Specifically, it is also conducted to seek answers from the following questions:

1. What are the mean scores of the STEM students during their pretest in terms of the following science process skills:

    1.1. Observing,

    1.2. Comparing,

    1.3. Classifying,

    1.4. Measuring,

    1.5. Gathering and Organizing Information,

    1.6.Predicting,

    1.7. Inferring,

    1.8. Evaluating,

    1.9. Synthesizing, and

    1.10. Interpreting Data?

2. How is the Science Investigatory Project Instruction developed and implemented?

3. What are the mean scores of the STEM students during their posttest in terms of the following science process skills:

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3.1. Observing,

3.2. Comparing,

3.3. Classifying,

3.4. Measuring,

3.5. Gathering and Organizing Information,

3.6. Predicting,

3.7. Inferring,

3.8. Evaluating,

3.9. Synthesizing, and

3.10. Interpreting Data?

4. Is there a significant difference between the mean scores of the pretest and posttest of STEM students in terms of the following science process skills:

   4.1. Observing,

   4.2. Comparing,

   4.3. Classifying,

   4.4. Measuring,

   4.5. Gathering and Organizing Information,

   4.6. Predicting,

   4.7. Inferring,

   4.8. Evaluating,

   4.9. Synthesizing, and

   4.10. Interpreting Data?

5. Is there a significant difference between the overall mean scores of the pretest and posttest of STEM students in their science process skills?

6. What action plan may be generated based from the findings of the study?

REVIEW OF RELATED LITERATURE

The present study anchors various literature and research studies to create a concrete foundation for conducting it. The review of related literature was presented according to the following themes: Challenges in Teaching and Learning Science; Science Investigatory Project; Perception on Science Investigatory Project; Implication on Doing Science Investigatory Project; and Science Process Skills.

Challenges in Teaching and Learning Science

Singh (2022) stated that one of the main problems with teaching science at higher secondary level is an overemphasis on memorization. This overemphasis leads to students being unable to engage in creative thinking and explore new ideas, which are essential skills for success in life. This problem can be resolved by reducing the focus on memorization while still ensuring that students have enough knowledge and understanding of scientific concepts before they move on to more advanced topics.

Also, Lane (2022) discussed the challenges that science teachers face include engaging students in learning, teaching complex topics, and managing classroom time effectively. Additionally, science teachers must be able to adapt their teaching methods to accommodate different learning styles and abilities.

In the Philippines, Ambag (2019) pointed out that shortage of classrooms for DepEd schools is also an issue in teaching science in primary schools. With the implementation of the K-12 program, Benjie Valbuena, national chair of the Alliance of Concerned Teachers-Philippines (ACT-Philippines) estimated the classroom shortage in the country to be 113,995 as of 2017. By June 2017, Education Undersecretary Jesus Mateo announced that 50,000 of the needed 113,000 classrooms had already been completed and are pending for use. The undersecretary stressed the objective of the government to create more classrooms "to meet lower class size, which leads to conducive learning."

In addition, Solomon (2021) concluded the top three (3) challenges encountered by the teachers along with the K to 12 Science curricula are the following: lack of laboratory equipment and chemicals, lack of instructional materials such as books, projectors, etc, and a limited number of classrooms. These identified challenges are perennial problems of DepEd teachers. Some teachers claimed that they have few laboratory equipment such as microscopes, test tubes, etc. but, they did not have a supply of chemicals which curtailed them from doing laboratory experiments. Most of the high schools had no separate laboratory room, teachers utilized their classrooms for laboratory activities/experiments. Moreover, some teachers declared that they have enough modules and books for the students however, they had a very limited number of available projectors and televisions. Teachers' desire to utilize technology in teaching is restrained because of this problem.

This is also supported by the study of Sadera et al. (2020) challenges encountered by Junior High School students in learning science. The study found out that the greatest challenge is on the instructional resources and medium of instruction.

While, Marteen (2019) recognized the need for a teacher to possess professionalism and conscientiousness in traits in teaching science. The study also mentioned that adequate knowledge and mastery of science teachers in the relevant subjects and familiarity with innovative techniques are essential factors.

Lastly, Best (2019) discussed that primary science teachers are faced with four big challenges namely: defining science, their own understanding of science, their students understanding of science, and finding the time to make science happen in the classroom.

With that, science teachers faced considerable challenges. These challenges are caused by limited subject matter knowledge, lack of support and resources, and pedagogical content knowledge. Thus, these factors affect preparation of lesson plans, choosing or devising activities, analogies to aid students' learning, answering students' questions, setting up laboratory experiments, linking and applying various concepts and principles to everyday life situations, generating students' interest and passion for the science area.

Moreover, Science teachers would usually have specialized one particular area of science. But in many cases, science teachers will be teaching within their area of expertise or outside their subject specialism. This situation led them to challenges in lesson preparation and science teaching.

Science Investigatory Project

Hothi (2020) defined Science Investigatory Project (SIP) as a science-based research project or study that is performed by school children. A SIP is usually a science experiment performed in a classroom setting with the class separated into small groups, but can also form part of a scientific exhibition or fair project. Its main purpose

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is to provide students with engaging ways to learn more about science and the concept of performing scientific research.

Likewise, Lebednik (2022) refers Science Investigatory Project as the use of the scientific method within an area of inquiry. SIP provides students practical experience in using the scientific method and help stimulate their interest in scientific inquiry.

According to Comia (2018), Science Investigatory Project is the usage of scientific method to study and test an idea about how something works. It involves researching, formulating a working theory that can be tested, conducting the experiment and recording and reporting the results. Thus, the science investigatory project gives students an opportunity to undergo the process of conducting an investigation using the scientific method making them gain a considerable understanding of the nature of obtaining solutions to problems or answers to questions in a systematic and scientific ways.

Manalo (2021) concluded that Science Investigatory Projects provide students the opportunity to apply their gained knowledge, skills, and attitude (KSA) in science. It helps to develop young researchers and improve the schools' science research program.

Likewise, Schreiner (2020) stressed that students learn to apply what they have learned, such as scientific concepts, theories, principles, and natural laws. They can conduct research using their higher-order process or thinking skills. Without the facilitating strategies of the teachers in charge, the students who participated in SIPs would not have gained anything. Thus, assessing teachers facilitating strategies is very relevant since it will give clues as to how to fill the gap for some students who are having difficulty doing their SIPs.

This is also supported by Collins (2021) who defines Science investigatory projects (SIPs) as science-based research projects for chosen areas of study that are performed by elementary, middle, or high school children. The study emphasized that these are science experiments which are designed to be either in-class group projects or individual projects. The intent of these assignments is to give younger learners a fun, interesting, and engaging way to learn about science and research.

Therefore, doing science investigatory project develops students' natural curiosity. They acquire the skills necessary to conduct inquiry and research and show independence in learning. Furthermore, these skills can be retained for future use if lessons are based on science investigations and practiced over a long period of time. Science programs that emphasize hands-on manipulative experiences such as conducting science investigatory project or researches, enhance the development of process skills in young children. Overall, doing an investigatory project considers a significant achievement for any STEM student.

Perception on Science Investigatory Project

Dimaandal (2022) discovered that students encountered difficulties in describing a problem, writing related material, identifying techniques and procedures, presenting, analyzing and interpreting data, summarizing findings, and creating recommendations when conducting science investigation projects. This is the reason why students perceived Scientific Investigation Projects as a method for gaining new ideas and knowledge. Additionally, there was a considerable correlation between the respondents' perceptions and the difficulties they have encountered.

In order to check the teachers' lens in doing Science Investigatory Project, Sanchez & Rosaro (2019) investigated the perspective and journey of the secondary schools' teachers in SIP instruction. The study revealed that the SIP instruction is affected by the teachers' prior background and implementation. Thus, they instill basic research skills to high school investigators, and develop the science character which is needed for them to engage in innovations in science and technology.

Implication on Doing Science Investigatory Project

Morsita (2020) stated that doing an investigatory project is considered as a major achievement of any students or teachers in Science Class. Through scientific investigation, students learned how to apply the acquired

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knowledge, scientific concepts, theories, principles, and laws of nature. Also, to apply their learnings through an investigatory project is beneficial in conducting academic researches since are using their higher-order process or thinking skills.

In addition, Shin (2019) explained that project-based learning enables students to find practical and complex problems by themselves, plan solutions, and perform collaborative research to solve problems. It is also supported by the study of Sambeka, Nahadi, & Sriyati (2017) which they explained that immersion in project-based tasks allowed students to undergo a rigid process of translating their curiosity into a workable hypothesis, experimentation, and verification. Thereby, providing the curriculum an authentic means of assessing scientific concepts and principles.

Hothi (2020) also gave emphasis to the research skills that students may acquire in doing Science Investigatory Project. These are defining research questions, formulating hypotheses, creating a study design, collecting and interpreting results, concluding the study, and presenting the work.

On the other hand, Lebednik (2022) discussed the relevance of doing Science Investigatory Project in physical science, chemistry, biology, astronomy, geology, medicine, economics, statistics and computational finance. Each of these disciplines has the potential to make scientific discoveries that can improve the lives of people, animals, or protection of environment, and society.

Cuartero (2016) looked on the impact of doing science investigatory project on the interest and process skills of elementary students. The data gathered were analyzed and interpreted using the frequency count and percentage computation, mean, standard deviation, and Analysis of Variance. Based on the findings, it was concluded that elementary students' interest in science and science process skills are developed by doing science investigatory project.

Furthermore, learning through Science Investigatory Project Instruction does not end in the four corners of the classroom alone. Due to its relevance to students' lives and the universally applicable problem-solving and critical thinking skills it uses and develops, science education is one of the most important subjects in school. These are life skills that allow students to generate ideas, make informed decisions, and even comprehend the evidence that informs public policy (Arrieta, 2020).

Science Process Skills

Science process skill is one of the important skills possessed by students in conducting scientific activities. It includes observing, experimenting, and analyzing activities. Science process skills are believed to be able to improve scientific literacy and help students understand science concepts easily and correctly. During the learning process, students are required to be active in discovering the main concepts through observation, experimentation, drawing pictures, graphs, tables, and communicating the results to others (Handayani et al., 2019).

Similarly, according to Padilla (2005) as mentioned by Norimune (2019), the fundamental scientific process abilities are observation, inference, measurement, communication, classification, and prediction. Likewise, Ilma et.al. (2020) mentioned that fundamental science process skills, which include the abilities to observe, classify, draw conclusions, and make predictions served as basis for learning and mastering more complex scientific process skills. Certainly, the science process skills are crucial for everyone to possess because they are virtually always applicable to daily life.

Meanwhile, science process skills are utilized to take care of issues and also to conduct experiments. Science process skills are cognitive and psychomotor talents aimed at conducting scientific inquiries, locating concepts, principles, and theories, and constructing pre-existing concepts (Novitasari & Aminatun, 2021).

Basically, Science process skills are defined as a set of skills that can be transferred, highly accepted in many fields of science, and reflect the behavior of scientists. Science process skills are described as the ability used by scientists during their work, and the competencies displayed in solving scientific problems. Scientists work by

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testing ideas with evidence through scientific methods and involving the efficient use of the Science Process Skills (Fugarasti et al., 2019).

Based from the study conducted by Gargarita (2021), if students' degree of participation in the execution of Science Investigation Projects is high, their Science Process Skills will reflect high as well. This study is conducted through descriptive-correlational which aimed to determine the Learners' Engagement in the conduct of Science Investigatory Project (SIP) and Its Influence to Science Process Skills among the Grade 8, 9, and 10 Special Program in Science, Technology and Engineering (SPSTE) learners of Tigbauan National High School, Tigbauan, Iloilo, Philippines for School Year 2020-2021. In addition, the researcher suggested that experiential learning and problem-based approach to be used to educate students on how to undertake a Science Investigation Project in order to enhance their science process abilities.

Unfortunately, Rusmini et al. (2021) studied the science process skills of chemical education students through Self-project Based Learning in the Covid-19 pandemic era. The study revealed that the respondents have low ability of science process skills although students gave a positive response to project implementation during a pandemic. It also emphasized that without the mastery of Science Process Skills, other thinking skills will be difficult to develop.

In line with that, there are studies claiming that Science Process Skills can be associated to various variables. For an instance, Derilo (2019) explored the basic and integrated Science Process Skills Acquisition and Science Achievement of Seventh-Grade Learners. The study revealed that basic Science Process Skills Acquisition was significantly related to the students' grade in science while the integrated Science Process Skills Acquisition is not. In conclusion, the results suggest that students' science process skills mastery may lead to better performance in science. Simply, it can be implied that the better the comprehension of the science process skills, the higher the performance in science will be.

Similarly, Suman et.al. (2020), there is a substantial positive association between Science Process Skills and Science Achievement. This indicates that pupils with higher levels of scientific process abilities fared better in science, and vice versa. Therefore, more focus should be placed on improving scientific process skills such as observation, categorization, inference, and data interpretation. In addition, Subasi (2022) found out that there is a moderate and positive relationship between scientific process skills and academic achievement of learners. According to this finding, as the use of scientific process skills increases, their academic success also increases.

Surprisingly, in a number of researches, it was found that mastery of science process skills has a positive effect on students' learning attitudes (Norimune, 2019).

Interestingly, Aydin-Gunbatar et al. (2019) concluded that Science Process Skills enhance learning and retention of ideas. It suggests that students must be actively involved in their activities while developing these skills through inquiry learning. Also, Samuel et al. (2018) concluded that Science Process Skills facilitate learning in physical sciences. It ensures active student participation, and have students develop a sense of undertaking responsibility in their learning, increase the permanence of knowledge, and have students acquire research ways and methods.

With that, some researches formulated recommendations regarding the possible ways and means in improving the students' process skills. Hardianti & Kuswanto (2017) concluded that in order to improve students' process abilities, a teacher may employ inquiry learning at levels commensurate with students' scientific experience and ability, which are then raised to greater degrees.

While, Celik (2022) suggested that utilization of interactive computer simulations can considerably increase students' science process skills. Lastly, Mutlu (2020) indicated that inquiry-based learning activities increased scientific process abilities such as problem definition, hypothesis formulation, observation, and interpretation during the inquiry-based learning process. Students also improved in their abilities to use scientific terminology, draw scientific and understandable diagrams, and formulate scientific explanations.

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METHODOLOGY

The researcher utilized the Descriptive Ex post facto research design. According to Saleh (2022), Descriptive Ex post facto research design which attempts to determine a cause-and-effect relationship between an independent variable and a dependent variable. The independent variable, however, cannot be manipulated or altered, in which ex post facto studies will look at how a particular characteristic, trait, or past occurrence affects the dependent variable. This research design was used to determine the effectiveness of Science Investigatory Project Instruction on students' science process skills.

Moreover, the researcher also utilized a one-group pre-test and post-test design for the data collection. According to Allen (2018), one-group pre-test and post-test design is a type of research design that is most often utilized by behavioral researchers to determine the effect of a treatment or intervention on a given sample. One of its features denotes that all participants are part of a single condition—meaning all participants are given the same treatments and assessments.

The procedures of the pre-experimental research with one-group pre-test and post-test design in this research were described as follows:

1. Administering a pretest (Y1) which proposed to measure students' process skills before the given treatment.
2. Applying the treatment or intervention (X) which was using SIP Instruction.
3. Administering a pretest (Y2) which proposed to measure students' process skills after the given treatment.

Specifically, the process from the conceptual model of the study was used to culminate the following stages or phases:

Development and Validation of SIP Instruction Plan

In this stage, the researcher designed the parts and layout of the SIP Instruction Plan. It also used the Science lessons from MELCs as prescribed by the DepEd to produce its content. In order to develop the required activities in each lesson that will promote the Science Process Skills, the researcher made use of reference books and other open-educational references. Thus, the researcher also crafted a performance task in the end of the semester which allowed the students to create and present their Science Investigatory Project or Invention. Moreover, the researcher critically developed inquiry or problem solving-based, output-based, and hands-on-based activities to anchor the relevant theories of the study namely: Theory of Engagement by Kearsley and Schneiderman and Theory of Experiential Learning by Kolb.

In terms of its validity, the SIP Instruction Plans were validated by three (3) Science Teachers who were responsible for the content quality. While, (2) English Teachers validated the grammar and instruction quality of the said materials. Overall, SIP Instruction Plans have passed the standards according to its validators.

Administration of the Pre-test for Science Process Skills

In this stage, the researcher collected and analyzed the needed quantitative data for the Pre-test from the 243 Science, Technology, Engineering and Mathematics (STEM) Grade 12 Senior High School students of a private school located at San Jose, Plaridel, Bulacan under the School Year 2022-2023. The subject respondents consisted of 141 male and 102 female students. The researcher administered a pre-test which targets to gauge the students' process skills at present. The students' science process skills include Observing, Comparing, Classifying, Measuring, Gathering and Organizing Information, Predicting, Inferring, Evaluating, Synthesizing, and Interpreting Data. The participants took (1) one hour to finish this 50-item diagnostic exam.

Implementation of the SIP Instruction to the Class Program

In this stage, the researcher personally taught the students using Science Investigatory Project Instruction. Therefore, lessons were aided with the validated SIP instruction Plan which anchors inquiry-based teaching and blended with laboratory activities that led them in making Science Investigatory projects. This intervention run for (1) one semester only during the School Year 2022-2023.

Administration of the Post-test for Science Process Skills

In this stage, the researcher administered the post-test to the students at the end of the semester. Basically, it still covers the above-mentioned Science Process Skills. The responses for the pretest and posttest regarding students' science process skills were quantified using simple error analysis. Then, the researcher employed descriptive measurements such as frequency, percentage, and mean value. Both tests were subjected to Paired T-test to check if the changes between the pretest and posttest were significant.

RESULTS AND DISCUSSION

STEM students' Scores during their Pretest in terms of Science Process Skills

In the beginning phase of this study, the researcher administered the pretest to gauge the level of science process skills of the STEM students. The test was conducted in the opening of second semester of school year 2022-2023. It was also done before exposing them to the Science Investigatory Project Instruction. The pretest anchored the science process skills namely: Observing, Comparing, Classifying, Measuring, Gathering and Organizing Information, Predicting, Inferring, Evaluating, Synthesizing, and Interpreting Data.

Table 1 Mean Scores during Pretest in terms of Science Process Skills

Science Process Skills	**Mean**	**Standard deviation**	**Descriptive Evaluation**	**Ranking**
Observing	2.05	1.291	Low Proficient	4
Comparing	1.60	1.077	Low Proficient	9
Classifying	2.38	1.252	Low Proficient	1
Measuring	1.65	1.160	Low Proficient	7
Gathering and Organizing Information	1.86	1.024	Low Proficient	5
Predicting	2.21	1.206	Low Proficient	2
Inferring	1.63	1.033	Low Proficient	8
Evaluating	1.66	1.014	Low Proficient	6
Synthesizing	2.08	.269	Low Proficient	3
Interpreting Data	1.35	.999	Low Proficient	10

*Legend: Highly Proficient – 4.5-5, Proficient – 3.5-4.49, Nearly Proficient – 2.5-3.49, Low Proficient – 1.5-2.49, Not Proficient – 1.0-1.49.

As presented in Table 1, the respondents have low proficiency in all science process skills as indicated in the weight mean scores. The Interpreting Data Skill (1.35) received the lowest mean value while Classifying Skill (2.38) is the highest. However, it only shows that the respondents during the pretest are lacking of competencies

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and application of their science process skills since all the aforementioned skills are categorized as Low Proficient.

Likewise, Raj & Devi (2014) examined the Science process Skills of high school students in five areas of Tamil Nadu. They further revealed that high school pupils had a very weak positive link between science process skills and science achievement.

Development and Implementation of the SIP Instruction

The development and validation of Science Investigatory Project Instruction Plan started in January 2022 after receiving the approval and permission for full implementation of Research Ethics Committee of La Consolacion University Philippines. The contents were solely based on Science lessons and Science Process Skills in which they have a low mastery level.

Table 2

Development and Implementation of the SIP Instruction
(Gantt Chart)

TASKS		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Week 19	Week 20	Week 21
Development and Validation Phase	Collecting of Resources and Crafting the Layout for the SIP Instruction Plan	X																				
	Creation of the SIP Instruction Plan	X	X																			
	Validation of the SIP Instruction Plan			X																		
	Revision of the SIP Instruction Plan				X																	
Administration of Pre-test	Pre-test for Science Process Skills					X																
Implementation of the SIP Instruction to the Class Program	SIP (Lesson 1)						X															
	SIP (Lesson 2)							X														
	SIP (Lesson 3)								X													
	SIP (Lesson 4)									X												
	SIP (Lesson 5)										X											
	SIP (Lesson 6)											X										
	SIP (Lesson 7)												X									
	SIP (Lesson 8)													X								
	SIP (Lesson 9)														X							
	SIP Performance Task															X	X	X	X	X		
Administration of Post-test	Pre-test for Science Process Skills																				X	
Data Analysis of the obtained scores from both tests																						X

Gantt chart of the Development and Implementation of SIP Instruction

Thus, the researcher obtained various references like books and Open-Educational Resources to support the content and activities of the SIP Instruction. Specifically, the researcher anchored the Theory of Engagement by Kearsley and Schneiderman and Theory of Experiential Learning by Kolb. With this, the researcher crafted critically the activities that promote active participation, engagement, and rich in experiential learning.

STEM Students' Scores during their Post-test in terms of Science Process Skills

The purpose of this study is to know the influence of Science Investigatory Project on students' science process skills. With that, the researcher employed the Science Investigatory Project Instruction in teaching science. The class was immersed to various inquiry-based and laboratory activities, and Science Investigatory Project Making. After four months and before the conclusion of school year 2022-2023, the researcher evaluated the students' science process skills using a post-test.

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Table 3 Mean Scores during Post-test in terms of Science Process Skills

Science Process Skills	Mean	Standard deviation	Descriptive Evaluation	Ranking
Observing	4.05	1.039	Proficient	9
Comparing	4.35	.816	Proficient	4
Classifying	4.38	1.089	Proficient	3
Measuring	4.12	1.107	Proficient	8
Gathering and Organizing Information	4.01	1.030	Proficient	10
Predicting	4.53	.887	Highly Proficient	2
Inferring	4.32	.870	Proficient	5
Evaluating	4.28	.897	Proficient	6.5
Synthesizing	4.81	.587	Highly Proficient	1
Interpreting Data	4.28	1.232	Proficient	6.5

*Legend: Highly Proficient – 4.5-5, Proficient – 3.5-4.49, Nearly Proficient – 2.5-3.49, Low Proficient – 1.5-2.49, Not Proficient – 1.0-1.49.

As presented in Table 3, the respondents are proficient in all science process skills as indicated in the weight mean scores. The mean scores range from Proficient to Highly Proficient weighing 4.01 (Gathering and Organizing Information Skill) to 4.81 (Synthesizing Skill). It further reveals that the respondents during the post-test are competent and have improved their science process skills due to the influence of Science Investigatory Project Structure Approach since all the aforementioned skills are categorized as High Proficient and Proficient.

Similarly, Suman et.al. (2020), studied the substantial positive association between Science Process Skills and Science Achievement. After the administration of treatment, which lasted five weeks, the same test was administered to the four groups as a post-test. The results revealed that SPSTA had a significant effect on students' achievement in Chemistry. The study concluded that pupils with higher levels of scientific process abilities were fared better in science, and vice versa.

Significant Difference between the Mean Scores of the Pretest and Post-test of STEM students in terms of science process skills

The mean scores for both pre-test and post-test are analyzed using descriptive analysis specifically: mean value and standard deviation. Based from the results, it is evident that the scores from the post-test or after employing the Science Investigatory Project Instruction. However, in order to assess the significant difference of the mean scores from both pre-test and post-test, the analyzed data were subjected to paired sample statistics.

Table 4 Significant Difference between the Mean Scores of the Pretest and Post-test in terms of science process skills

Science Process Skills	Test Type	Mean	SD	t-value	Sig. value	Interpretation	Decision to Ho
Observing	Pre-test	2.05	1.291	-17.829	0.000	Significant	Reject
	Post-test	4.05	1.039				

Comparing	Pre-test	1.60	1.077	-31.506	0.000	Significant	Reject
	Post-test	4.35	.816				
Classifying	Pre-test	2.38	1.252	-18.254	0.000	Significant	Reject
	Post-test	4.38	1.089				
Measuring	Pre-test	1.65	1.160	-23.625	0.000	Significant	Reject
	Post-test	4.12	1.107				
Gathering and Organizing Information	Pre-test	1.86	1.024	-24.380	0.000	Significant	Reject
	Post-test	4.01	1.030				
Predicting	Pre-test	2.21	1.206	-23.962	0.000	Significant	Reject
	Post-test	4.53	.887				
Inferring	Pre-test	1.63	1.033	-30.180	0.000	Significant	Reject
	Post-test	4.32	.870				
Evaluating	Pre-test	1.66	1.014	-31.066	0.000	Significant	Reject
	Post-test	4.28	.897				
Synthesizing	Pre-test	2.08	.269	-67.068	0.000	Significant	Reject
	Post-test	4.81	.587				
Interpreting Data	Pre-test	1.35	.999	-28.313	0.000	Significant	Reject
	Post-test	4.28	1.232				

$\alpha = 0.05$ Level of Significance

Table 4 shows the mean comparison test of pretest and posttest of all the science process skills. As gleaned from the table, all yielded significant results reflective of the sig. values all less than $\alpha = 0.05$. Looking at the descriptive statistics of the learners' performance in the science process skills for both pretest and posttest, it was apparent that all the scores increased remarkably in the posttest when compared with the pretest.

These findings are also similar to the study conducted by Gargarita (2021), it said that students' degree of participation in the execution of Science Investigation Projects is influential to Science Process Skills. In the present study, the students were exposed highly to experiential and problem-based learning under a Science Investigatory Project Instruction. Basically, the Science Investigatory Project Structure Approach contributes in enhancing their science process abilities or skills.

Moreover, it supports the researcher's hypothesis that there is a significant influence from Science Investigatory Project towards the science process skills of the STEM students. Therefore, the null hypothesis is rejected.

Significant Difference between the Overall Mean Scores of the Pretest and Post-test

Aside from the science process skills, the researcher also sought to examine if the difference from the overall scores of pre-test and post-test is significant. With that, the analyzed data using descriptive measures from the overall scores were subjected to paired sample statistics.

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Table 5 Significant Difference between the Overall Mean Scores of the Pretest and Post-test

Test Type	Mean	Standard deviation	t-value	Sig. value	Interpretation	Decision to Ho
Pre-test	18.46	4.95	-47.674	0.000	Significant	Reject
Post-test	43.14	5.64				

α = 0.05 Level of Significance

Table 5 shows the mean comparison of the overall science process skills in the pretest and posttest. It can be gathered from the table that there is a significant difference in the scores of learners in these tests with a t-value of -47.674 with the corresponding probability value of 0.000 which is less than α = 0.05.

These findings are relevant to Jugar (2013) regarding the cognitive ability of creating meaning and structure from new information and experience. This ability is referred as science process skills. In the present study, the students received high scores from the post-test after their immersion to Science Investigatory Project Instruction. Therefore, the experiential and problem-based learning from Science Investigatory Project Instruction contributes in creating meaning and new information that leads to high performance in the post-test.

Proposed Action Plan may be generated based from the findings of the study

Based on the results, it revealed that the students' science process skills have improved after undertaking the science class with Science Investigatory Project Instruction. However, the researcher proposes to utilize the proposed action plan below entitled "Supplementary Learning Activities for Science Process Skills" for instances where mastery is not achieved yet in various Science Process Skills despite the strategy or utilization of the SIP Instruction Plan.

Table 6 Proposed Action Plan

Supplementary Learning Activities for Science Process Skills		
Science Process Skills	**Supplementary Activity**	**Task**
Observing and Comparing	Look. Observe. Compare.	The teacher will provide an activity sheet with pictures that requires students to compare and contrast topics using Venn diagrams or charts. Examples are types of leaves arrangement, types of animal kingdoms, or dominant and recessive genes.
Classifying	Picture Gallery	The teacher will provide a gallery. The students must classify and group the topics related to each other. Examples are Genetically Modified Organisms, Body Systems, and Types of Fossils.
Measuring	Watch and Recreate	The teacher will provide a Video Instruction about a simple experiment that involves measuring activities. The students will recreate it after watching. Examples are creating a model or experiment about fossils, DNA, and starch.

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Gathering and Organizing Information	Survey and Interview Time	The teacher will provide a questionnaire that students will use to gather data from their relatives. They must organize the data afterwards. Examples are heredity and common plants from their area.
Predicting, Inferring, and Evaluating	Open-Ended Questions	The teacher will provide real-life scenarios that are relevant today. They must provide possible outcome. Examples are lifestyle and health.
Synthesizing	Booklet Making	The teacher will provide topics and students must look for resources. They will document it and create a booklet to promote awareness. Examples are genetic disorders, global warming, etc.
Interpreting Data	Analyze the Graph	The teacher will provide graphs with data and the students must interpret the graph by answering the guide questions. Examples are disasters, population, diseases.

CONCLUSION AND RECOMMENDATION

Conclusion

The major concern of the study was to determine significant difference of the mean scores before and after the implementation of Science Investigatory Project Instruction. The results demonstrated that there is a significant influence from Science Investigatory Project towards the science process skills of the STEM students.

In the beginning, the mean scores of all the science process skills during the pre-test or before the Science Investigatory Project Instruction are all considered below average or poor. Specifically, Interpreting Data with 1.35, Comparing with 1.60, Inferring with 1.63, Measuring with 1.65, Evaluating with 1.66, Gathering and Organizing Information with 1.86, Observing with 2.05, Synthesizing with 2.08, Predicting with 2.21, and Classifying with 2.38. Overall, all the above-mentioned skills of the students are categorized as low proficient.

Whereas, the mean scores of all the science process skills during the post-test or after the Science Investigatory Project Instruction are all considered as average and above average. Specifically, Gathering and Organizing Information with 4.01, Observing with 4.05, Measuring with 4.12, Evaluating and Interpreting Data with 4.28, Inferring with 4.32, Comparing with 4.35, Classifying with 4.38, Predicting with 4.53, and Synthesizing with 4.81. Overall, all the above-mentioned skills of the students are categorized as proficient and highly proficient.

Further, the mean comparison test of pretest and posttest of all the science process skills yielded significant results reflective of the sig. values (0.00) all less than $\alpha = 0.05$. Therefore, all the increased scores in the post-test compared with the pre-test are remarkable and significant.

Moreover, the mean comparison of the overall science process skills in the pretest and posttest indicates a significant difference in the scores of learners in these tests with a t-value of -47.674 with the corresponding probability value of 0.000 which is less than $\alpha = 0.05$.

As a result of using science investigatory project instruction, the students' science process skills have improved. Therefore, the researcher suggests incorporating Science Investigatory Project Instruction into the teaching of science courses. Meaning that for the actual lesson, it is advised to develop inquiry- and experiential-based activities rather than a discussion-based method to teaching science. The development of Science Investigatory Projects as genuine outcomes at the conclusion of the semester is equally significant. This action plan will emphasize the development of meaning and application of scientific information, which will strengthen the scientific method.

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Recommendation

Based on the findings and conclusion of the study, the following recommendations are hereby offered:

1. The result of this research study must be presented to its research locale to further improve its science courses. Since the Science Investigatory Project Instruction is proven influential in improving science process skills, it is suggested to incorporate the intervention to other science subjects in different levels. In that way, at a young age, students can improve the said skills as early as possible.

2. Science teachers must bring back the experiential and engagement approach in teaching by utilizing science laboratories physically. Due to pandemic, laboratory-based and other experiment-based activities are either refrain or delimits. With that, using the Science Investigatory Project Instruction in teaching students, it can allow teachers to create activities as facilitator and transform their teaching habits to learner-centered.

3. School Administrators must encourage their science teachers in attending workshops and trainings related to inquiry-based teaching and research-based approach. The said training is beneficial for them to utilize this type of instruction in teaching science effectively while targeting the science process skills.

4. It is also suggested to require the students under Science Investigatory Project Instruction to create authentic outputs and present them in the final term or as performance task. Since creating a Science Investigatory Project is also quite similar to a research writing, it can also improve other skills aside from science process skills. It can help to improve literacy, communication skills, and research skills.

5. This paper also calls for further studies that will explore more variables connected to the Science Investigatory Project Instruction to the learners. This paper will serve as a stepping stone for its future endeavors.

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