HANDS-ON, MINDS-ON: A PRACTICAL EXPERIMENTS IN ENHANCING THE SCIENCE PROCESS SKILLS OF THE STUDENTS

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ABSTRACT

In this study, the impact of a hands-on, minds-on practical experiment on the development of students' science process skills was thoroughly examined. Two groups, a control group and an experimental group, were subjected to pre-tests and post-tests to assess changes in their science process skills. The results revealed significant improvements in both basic and integrated science process skills in the experimental group compared to the control group, validating the effectiveness of the practical experiment intervention.

Initially, both groups exhibited a "Low Understanding" of basic science process skills and an "Inadequate" level of integrated science process skills. However, after the intervention, the experimental group demonstrated a "Proficient" level in basic science process skills and a "Highly Proficient" level in integrated science process skills. The control group, in contrast, reached only an "Adequate" level for basic science process skills and an "Adequate" level for integrated science process skills. Statistical analyses showed significant differences between the groups post-intervention, further confirming the positive impact of the hands-on, minds-on practical experiment on science process skills.

These findings underscore the importance of targeted interventions to enhance science education and emphasize the need for evidence-based teaching methods. Educators and researchers can draw from this study to design interventions that address specific deficiencies in science understanding and application, thus promoting scientific proficiency among students. This research sets a standard for future investigations in the field of science education, encouraging the development of effective instructional practices to equip students with essential skills in an ever-evolving world.

Keywords: *Hand-On Minds-On, Practical Experiment, Science Process Skill*

INTRODUCTION

The concept of "hands-on science" is a teaching strategy that actively engages students in manipulating natural phenomena or objects to gain knowledge and comprehension. Haury and Rillero (1994) introduced this approach, emphasizing the importance of experiential learning in science education. The rationale for hands-on science is rooted in the idea that students require real-world experiences and support in integrating their knowledge to fully grasp scientific concepts, aligning with the National Science Education Standards (1995).

In hands-on science activities, students not only learn through doing but also engage in "mind-on learning," where they think critically about what they are learning and doing. This approach goes beyond mere manipulation and encourages higher-order thinking and problem-solving, as suggested by Hofstein and Lunetta (1982) and Victor and Kellough (1997).

Science Process Skills (SPS) play a crucial role in hands-on science education, involving skills like synthesizing knowledge, problem-solving, and drawing conclusions. SPS facilitates scientific inquiry, acquisition of research methods and skills, and active learning (Ayas et al., 2007). These skills can be classified into basic and integrated categories, encompassing various abilities like observation, measuring, classifying, predicting, controlling variables, hypothesizing, experimentation, and data interpretation. Mastering these skills is essential for excelling in science inquiry and hands-on science activities (Ngoh, 2009).

The value of experiments in science education cannot be overstated, as they enhance the learning experience. Conducting experiments in science classes benefits learners, as noted by many educators and scientists (Bretz, 2019). Building on this foundation, the concept of practical experiments emerged, offering students safe yet engaging experiments that can be conducted at home. This research aimed to assess whether such experiments could help Grade 8 students at Binan Secondary School of Applied Academics enhance their scientific process skills, aligning with the goals of the Basic Education Development Plan (BEDP) 2030, which strives to ensure that all learners achieve learning standards in every key stage of the K to 12 program.

In summary, hands-on science education, along with the development of science process skills, contributes to a comprehensive and effective science learning experience. These strategies align with educational standards and promote the goals of enhancing students' scientific understanding, critical thinking, and problem-solving abilities.

RESEARCH QUESTIONS

The study was anchored to one of the pillars of the Basic Education Development Plan (BEDP) 2030, which aimed to ensure that learners completed K-12 basic education, having successfully attained all learning standards that equipped them with the necessary skills and attributes to pursue their chosen paths.

Specifically, it seeks to answer the following questions;

1. What is the basic and integrated level of science process skills during pre-implementation of the;
   a. control group
   b. experimental group
2. What is the basic and integrated level of science process skills during post implementation of the:
   a. control group
   b. experimental group
3. Is there a significant difference in the basic and integrated level of science process skills of the control group before and after implementation?
4. Is there a significant difference in the basic and integrated level of science process skills of the experimental group before and after implementation?
5. Is there a significant difference in the post implementation on basic and integrated level of science process skills between the control and experimental group?
6. What are the challenges encounter by the experimental group?

METHODOLOGY

Grade 8 in Biñan Secondary School of Applied Academics was the selected population for the study. The samples for the experimental and control groups were chosen by the researcher, who utilized a purposive sampling method to select students from the Grade 8 student population. Each group consisted of 30 students. The researcher presumed that learners in both groups had comparable ages and abilities based on their 2nd quarterly grades and the available age profile. This presumption was made because the school employed heterogeneous grouping when assigning students to different sections. The researcher employed a quasi-experimental design and a qualitative approach since the participants in the experimental and control groups were not randomly assigned. Instead, purposive sampling was applied to select participants for each group.

Pretests and posttests were administered as part of the study. A pre-test was given to assess the students' science process skills before the experiment's implementation, and a post-test was conducted to determine whether there was any change in their science process skills after the experiment. The students' scores on the Science Process Skills Test were categorized based on the mean scores range provided by Ngoh (2009).

The researcher developed a practical experiment that allowed students to perform activities at home. This experiment underwent modifications, refinements, and revisions after consultation with fellow science colleagues, the head teacher in science, and the master teacher in science. Pre-tests and post-tests were also created to align with the Science Process Skill Test (SPST), focusing on basic science process skills and integrated science process skills. The instrument's reliability was determined through pilot testing involving Science 8 students from non-participating sections.

This elicited varied response including

RESULTS

The research was designed to explore the impact of a hands-on, minds-on practical experiment on students' science process skills. By comparing the experimental group's experience with the conventional group's traditional teaching, the study aimed to shed light on the effectiveness of innovative teaching methods in enhancing science education. Specifically, the following results were gathered:

Table 1. *Comparison of Pre-Test Mean Score of Basic Science Process Skills of Control and Experimental Group*

Group	Mean	Interpretation
Control	1.23	Low Understanding
Experimental	1.3	Low Understanding

Table 1 displayed the pre-test mean scores of the control and experimental groups. The data showed that the mean score for the control group was 1.13, while the experimental group scored 1.3. This indicated that both groups were categorized as having a "Low Understanding" of basic science process skills. Students in this range had very limited understanding of basic science process skills, and they struggled to follow instructions, make basic observations, or collect rudimentary data. Because both groups were categorized as having low understanding, they were comparable to each other.

Table 2. *Comparison of Pre-Test Mean Score of Basic Science Process Skills of Control and Experimental Group*

Group	Mean	Interpretation
Control	2.57	Adequate
Experimental	3.87	Proficient

Table 2 displayed the post-test mean scores of the control and experimental groups. The data revealed that the mean score for the control group was 2.57, which was interpreted as "Adequate." Students at this level had a basic proficiency in science process skills. They could follow instructions, make simple observations, and collect data with moderate accuracy. On the other hand, in the experimental group, the mean score was 3.87, which was interpreted as "Proficient." Students at this level demonstrated proficiency in science process skills. They could follow instructions, make accurate observations, collect and analyze data effectively, and draw logical conclusions. Although both groups increased stheir mean scores after the intervention, it was evident that the experimental group had higher mean scores.

Table 3 displayed the pre-test mean scores of the control and experimental groups. The data revealed that the mean score for the control group was 1.3, while the experimental group also scored 1.3. This indicated that both groups were categorized as having an "Inadequate" level of integrated

Table 3. *Comparison of Pre-Test Mean Score of Integrated Science Process Skills of Control and Experimental Group*

Group	Mean	Interpretation
Control	1.3	Inadequate
Experimental	1.3	Inadequate

science process skills. Students in this range have very adequate understanding of integrated science process skills. They may struggle to integrate knowledge and skills from different scientific disciplines, making it difficult to apply them to real-world problems.

Table 4 displayed the post-test mean

Table 4. *Comparison of Post Test Mean Score of Integrated Science Process Skills of Control and Experimental Group*

Group	Mean	Interpretation
Control	2.2	Adequate
Experimental	3.43	Highly Proficient

scores of the control and experimental groups. The data revealed that the mean score for the control group was 2.2, which was interpreted as "Adequate." Students at this level are in the process of developing their integrated science process skills. They can begin to connect concepts from different scientific domains and use them to address simple interdisciplinary problems. On the other hand, in the experimental group, the mean score was 3.43, which was interpreted as "Highly Proficient.". Students at this level demonstrate proficiency in integrated science process skills. They excel at connecting and applying concepts across scientific fields, addressing complex interdisciplinary challenges, and effectively communicating their findings to both experts and non-experts.

Table 5 illustrated a notable test significance difference in the basic science process skills of the control group, with a 95% confidence interval. The P-value, which was lower than the confidence interval, led to the decision to reject the null hypothesis (Ho). This result was interpreted as statistically significant, indicating that there was a meaningful divergence in the basic science process skills of the control group.

The findings presented in Table 6

Table 5. *Test Significance Difference in Basic Science Process Skills of Control Group (95% confidence interval)*

Test	N	X	df	T value	P value	Decision	Interpretation
Pre-Test	5	7.4	8	5.25	0.0008	Reject Ho	Significant
Post Test	5	15.4					

highlight a remarkable and statistically significant difference in the integrated science process skills of the control group. This assessment was conducted with a 95% confidence interval, and the calculated P-value (0.0015) was substantially lower than the predetermined confidence level of 0.05. Consequently, the decision was made to reject the null hypothesis (Ho). This outcome signifies a significant and meaningful variation in the integrated science process skills within the control group, as confirmed by the statistical analysis.

Table 6. *Test Significance Difference in Integrated Science Process Skills of Control Group (95% confidence interval)*

Table 7. *Test Significance Difference of Basic Science Process Skills of Experimental Group (95% confidence interval)*

Test	N	X	df	T value	P value	Decision	Interpretation
Pre-Test	5	7.8	8	8.2553	0.0001	Reject Ho	Significant
Post Test	5	23.20					

The data revealed in Table 7 emphasize a significant and statistically meaningful distinction in the basic science process skills exhibited by the experimental group. This examination was carried out with a 95% confidence interval, and the resulting P-value (0.0001) was markedly below the predetermined confidence level of 0.05. As a result, the decision was made to reject the null hypothesis (Ho). These findings unequivocally indicate a substantial and significant variation in the basic science process skills within the experimental group, as validated through rigorous statistical analysis.

The data displayed in Table 8 underline a significant and statistically meaningful disparity in the integrated science process skills demonstrated by the experimental group. This analysis was conducted using a 95% confidence interval, and the resulting P-value (0.0006) was significantly lower than the predetermined confidence level of 0.05. Consequently, the decision to reject the null hypothesis (Ho) was made. These results undeniably signify a substantial and significant divergence in the integrated science process skills within the experimental group, reaffirmed by a thorough and rigorous statistical analysis.

The data presented in Table 9 underscore a substantial and statistically significant difference in the post-test scores for basic science process skills between the control and experimental groups. This examination was carried out with a 95% confidence interval, and the computed P-value (0.0034) was notably lower than the predetermined confidence level of 0.05. As a result, the decision was made to reject the null hypothesis (Ho). These findings undeniably point to a significant and substantial divergence in the basic science process skills between the control and experimental groups, further validated by comprehensive and rigorous statistical analysis.

Table 8. *Test Significance Difference of Integrated Science Process Skills of Experimental Group (95% confidence interval)*

Test	N	X	df	T value	P value	Decision	Interpretation
Pre-Test	4	9.75	6	6.5548	0.0006	Reject Ho	Significant
Post Test	4	25.75					

The data in Table 10 highlighted a significant and statistically meaningful contrast in post-test scores for integrated science process skills between the control and experimental groups. This analysis was conducted with a 95% confidence interval, and the computed P-value (0.0106) was notably lower than the predetermined confidence level of 0.05. Consequently, the decision was made to reject the null hypothesis (Ho). These results undeniably signify a substantial and significant disparity in integrated science process skills between the control and experimental groups, further supported by comprehensive and rigorous statistical analysis.

Table 9. *Test Significance Difference of Post Test Score in Basic Science Process Skills of Control and Experimental Group (95% confidence interval)*

Groups	N	X	df	T value	P value	Decision	Interpretation
Control	5	15.40	6	4.1110	0.0034	Reject Ho	Significant
Experimental	5	23.20					

DISCUSSION

Based on the data analyzed and interpreted, the following were summarized as answers to the questions.

Table 10. *Test Significance Difference of Post Test Score in Integrated Science Process Skills of Control and Experimental Group (95% confidence interval)*

Groups	N	X	df	T value	P value	Decision	Interpretation
Control	4	17	6	3.6556	0.0106	Reject Ho	Significant
Experimental	4	25.75					

1. What is the basic and integrated level of science process skills during pre-implementation of the control group and experimental group?
    - The pre-test mean scores of both groups indicated that they both had a 'Low Understanding' of basic science process skills. This implies limited abilities in following instructions, making observations, and collecting data.
2. What is the basic and integrated level of science process skills during post implementation of the control group and experimental group?
    - The post-test mean scores show improvement in both groups. The control group achieved an "Adequate" level, while the experimental group reached "Proficient" in basic science process skills, with the experimental group showing higher scores. In terms of integrated science process skills initially, both groups had an "Inadequate" understanding. However, the post-test scores demonstrate significant improvement. The control group reached an "Adequate" level, while the experimental group achieved "Highly Proficient," indicating their superior skills in integrating scientific concepts.

For Question Number 3-5

3. Is there a significant difference in the basic and integrated level of science process skills of the control group before and after implementation?
4. Is there a significant difference in the basic and integrated level of science process skills of the experimental group before and after implementation?
5. Is there a significant difference in the post implementation on basic and integrated level of science process skills between the control and experimental group?
   - Based on the data, it confirms significant differences in the basic science process skills of the experimental group and post-test scores between the control and experimental groups. These results are supported by rigorous statistical analysis with a 95% confidence level and low P-values.

Overall, the study demonstrates that the intervention or the Hands On Minds On Practical experiment had a substantial impact on both basic and integrated science process skills. The experimental group consistently outperformed the control group, and the improvements were statistically significant. This research highlights the effectiveness of the intervention in enhancing students' science process skills, particularly in integrating knowledge from different scientific disciplines.

In conclusion, the data presented in Tables 1 to 9 offer a comprehensive and insightful assessment of the impact of an educational intervention on the science process skills of both control and experimental groups. Initially, both groups exhibited a "Low Understanding" of basic science process skills, indicating limited proficiency in fundamental scientific activities. However, following the intervention, the experimental group significantly outperformed the control group, achieving a "Proficient" level, reflecting their heightened competence in science process skills.

Furthermore, the integrated science process skills displayed a similar pattern, with both groups initially categorized as "Inadequate." After the intervention, the experimental group demonstrated a "Highly Proficient" level, showcasing their exceptional ability to integrate knowledge and skills across scientific domains and solve complex interdisciplinary challenges.

Statistical analysis confirmed these improvements, with significant differences observed in both basic and integrated science process skills between the control and experimental groups post-intervention. These results emphasize the effectiveness of the educational intervention or the Hands On Minds On Practical Experiment in enhancing students' science process skills and highlight the importance of targeted instructional approaches for fostering scientific proficiency.

ACKNOWLEDGEMENTS

The researcher wishes to express their deepest appreciation and gratitude to the following individuals for their invaluable contributions, which led to the completion of this study:

The top management of the City Schools Division of Biñan City, headed by the Schools Division Superintendent, Ma'am Manuela S. Tolentino, CESO V; OIC Assistant Schools Division Superintendent, Edenia O. Libranda; SGOD Chief, Sir Bayani V. Enriquez; and CID Chief, Ma'am Mary Ann L. Tatlongmaria, for their efforts and invaluable inputs on the approval and conduct of the study.

Our Principal II, Leslie V. Denosta, DEM, for approving and supporting the study.

The evaluators of research instruments and pre and post tests, Mr. Patrick James Pelicano, Master Teacher I in English; Ms. Lhane Grace B. Bayoneta, Master Teacher I in Science; and Mrs. Raissa J. Janaban, Head Teacher II in Science, for their thorough evaluation of the research instruments.

Our Research Coordinator, Diane M. Furio, for sharing and providing input for our study.

Lastly, we extend our gratitude to the Almighty God, the source of knowledge, strength, and wisdom.

Thank you very much. This research is dedicated to all of you.

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