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Inquiry-Based Learning Resource Material for Improved Integrated Process Skills in Elementary Science

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ABSTRACT: Poor science education techniques may lead to low science competence. The shift in education tends to be in distance learning, which negatively impacts Philippine Education. Consequently, educators are looking for the best innovations to help bridge the science education gap, especially in teaching techniques. This study focuses on developing an inquiry-based learning resource to enhance the integrated science process skills of Grade 4 students in Science at Del Remedio Elementary School, San Pablo City, Philippines. Descriptive-developmental methodology was used for this study, which is a process aimed at developing and evaluating a learning tool. The participants of this research are the grade 4 learners of Del Remedio Elementary School. The developed inquiry-based learning resources meet the criteria of being highly acceptable in terms of graphic design and layout feasibility, construction feasibility, language feasibility, and content feasibility, as per the findings. The dependent samples t-test revealed that students' pre-test and post-test scores are significantly different from their integrated science process skills; this implies that their grades improved after inquiry-based learning. The Pearson Product-Moment correlation shows a significant relationship between the students; inquiry-based learning technique and their level of integrated science process skills, with a significant level of 0.05. This led to the conclusion that the technique implemented to be used in the developed resource material helps students improve their understanding of the lesson, leading them to higher achievements.

KEYWORDS: inquiry-based science education, integrated science process skills, teaching strategy

I. INTRODUCTION

Inquiry-based learning is a method that keeps students interested by establishing links to the real world through investigation and challenging questions. It encourages pupils to engage fully in problem-solving and experiential learning. Teaching pupils how to engage in inquiry is one of the most essential objectives of science education. Students should integrate their skills, knowledge, and attitudes toward science to understand scientific concepts better. Therefore, the focus of teaching skills should be on facts, theories, and concepts to encourage students to involve themselves in scientific inquiry (Dela Cruz et al., 2015).

The basic concept of inquiry-based learning refers to learners' self-discovery. The learners or the students are guided to inquire or generate relevant questions and to produce the appropriate answers through critical thinking. In inquiry-based learning, learners are exposed to how knowledge is generated and shared and how all stakeholders, including professionals, teachers, parents, and society, contribute to learners' knowledge. is also shown. This learning style tends to be more enjoyable for the students because they actively participate in their learning (Guevarra & Panoy, 2022). An unconventional approach to education, inquiry-based learning involves students' active engagement by having them ask questions and share real-world experiences. The foundation of this approach is to direct students' mental processes through questions and teach them "how to think" rather than "what to think." Through exploration and challenging questions, pupils are kept interested in their literacy through inquiry-based learning. It is a system of instruction that promotes pupils' participation in existential literacy and problem-working. There is so much important going on in the world that our pupils should learn about and experience.

According to Romadhona and Suyanto (2020), integrated science process skills level up from the basic science process abilities required to understand science. Scientific inquiry and literacy depend critically on integrated science process skills (ISPS). The application of scientific knowledge and scientific inquiry is necessary for living and working in the 21st century (Guevarra, 2015). Thus, excellent students will be prepared for this skill (Chockchai, 2019). Developing and using science process skills in scientific inquiry are necessary to learn to perform science (Agno & Panoy, 2023).

In Del Remedio Elementary School, poor science competence is a serious challenge that needs to be addressed. Performance ratings and mean percentage scores on school-based performance tests over the past four years of this school descent. An average mean percentage score (MPS) of 80.21 was recorded in 2018-2019. An increase was recorded in 2019-2020 with an MPS of 84.61. During the implementation of distance learning, from the years 2020-2021 and 2021-2022, the MPS consecutively reached 85.55 and 83.15. This school year, 2022-2023, a diagnostic and quarterly test was conducted to assess the pupil's knowledge and learning gaps. Grade 4 teachers conducted the science test, and the result of the MPS is quite alarming. The MPS for the diagnostic test descends to 40.18. During the first quarterly test, the result of the MPS was 75.35, which is lower than in previous years.

Most science teachers reported the same results and struggled to include investigations and hands-on learning for pupils. The learning gap during remote learning affects the learning process. Teachers cited difficulties in getting pupils to engage in collaboration and discussion. Yusuf et al. (2022) indicated that learning accompanied by guided activities created by the IBL approach significantly impacts students' critical-thinking abilities in science and technology courses. In this case, the pupil's engagement and interest in the lesson will also be uplifted. They can answer problems scientifically and may be able to relate and use these ideas for everyday use.

There are findings indicating that pupils who received instruction through inquiry-based learning outperformed those who received traditional instruction (Tawfik et al., 2020). An inquiry-based learning model represents the combination of information and abilities that is a defining aspect of the learning process via inquiry. This visually represents how using scientific inquiry skills (predicting, hypothesizing, collecting and interpreting data, and drawing conclusions) leads to developing scientific knowledge and understanding (Kelley et al., 2020). Meanwhile, teachers can develop teaching assessments to address learning gaps and improve the integrated process skills of Grade 4 pupils. Helping pupils in the different classroom activities will encourage them to do better in class, help them understand the lesson, and help them apply the process of understanding (Lati et al., 2012). They may also be influenced by being guided correctly in every action they must take.

With this premise, the researcher is interested in considering inquiry-based education in science as an aid in teaching science, enhancing the science process skills and pupils' engagement in learning within the classroom. That is why the researcher intends to focus her study on developing inquiry-based learning resource material for enhanced integrated science process skills for the Grade 4 pupils of Del Remedio Elementary School.

Objectives of the Study. This study focuses on developing an inquiry-based learning resource that bridges the gap in science competence by enhancing the integrated process skills of Grade 4 students in Science at Del Remedio Elementary School. Specifically, 1) to analyze whether the pre- and post-assessment scores of the respondents are significantly different, and 2) to evaluate the inquiry-based learning resource through materials experts' validation.

II. RESEARCH METHODOLOGY

Research Design. The descriptive-developmental research design used in this study is a procedure for learning product creation and validation. Fuertes et al. (2020) asserts that descriptive approaches look for facts in the current situation. The approach also emphasizes summarizing, contrasting, examining, and interpreting existing data. Mann et al. (2022) describe development techniques as a body of study literature specifically relevant to educational development, implying that results are created once this research is complete. Descriptive development methods, in other words, are the methodical study of the development, construction, and thorough evaluation of educational programs, methods, and products that need to adhere to standards. The development approach ADDIE (Spatioti et al., 2022) is also used. The ADDIE model includes learning activities designed and developed expressly to jump-start the learning process for the student. During this phase, students gain the knowledge, abilities, and attitudes necessary for their jobs and vocations.

The researcher chose this design because it aims to create an inquiry-based learning resource material to enhance integrated science abilities for Grade 4. It is descriptive to clarify the degree of the result with the instrument used. Developmental research is the scientific study of creating, generating, and assessing educational programs, processes, and products that must meet internal consistency and effectiveness standards. This contrasts with fundamental instructional development. Development research is important in educational technology (Reyes & Aliazas, 2021). It is a development study because it deals with situations where the product development process is analyzed and described, and the final product is evaluated. We also focus on the impact our products have on learners and organizations. (Morgan & Liker, 2020)

To create the learning resources (BOW), the K–12 Science curriculum and the subject's competencies were examined and evaluated following DepEd's Most Essential Learning Competencies (MELC) and the Budget of Work.

Respondents of the Study. The respondents for this research were forty (40) grade 4 pupils who are officially enrolled in Del Remedio Elementary School for the academic year 2022–2023. The pupils were given a diagnostic test identifying which integrated science process skill they needed an intervention. The participants then undergo the inquiry-based learning material treated or intervened with and then assessed again to identify the change or difference between the initial (pre-) and second (post-) measurements. Science experts in the school will validate the inquiry-based learning material and the teacher-made test: specifically, 3 Master teachers, 3 School Science coordinators/teachers, 3 English teachers and the principal from where the researcher is assigned.

Research Instruments. The researcher prepared a diagnostic test for Grade 4 pupils to test their level of knowledge in applying the integrated science process skills. After identifying the skills where they need an intervention, a pre-test and post-test measuring the integrated science process skills were validated by 3 master teachers, 3 school science teachers and 3 English teachers for the language structure.

Science teachers and English teachers, who were co-teachers of the researcher, validated the instrument in terms of content. In addition, 3 Master teachers at Del Remedio Elementary School carefully validated the instruments in terms of the content of the questions, even the structure of the pretest and posttest instruments. The validators see to it that the alignment of the instrument in the specifications table and even the number of days that the lessons were delivered were observed. Validators, together with the researcher, see that Grade 4 pupils can answer the instruments.

The pretest and posttest instruments were drafted with a focus on science competencies. More so, the instruments were revised and finalized to ensure that they contained all the pertinent information and data needed for the study. The instrument included a pre-test and a post-test. The pre-test will be given before the strategy is used, while the post-test will be given after it. Each instrument consists of 40 questions. Those instruments were used to measure the respondents' integrated science process skills, and it was a teacher–made test in Science 4. Furthermore, the researcher drafted the lesson plan used to execute the inquiry-based learning resource materials. The developed inquiry-based learning resource material was also validated. On the other hand, the experts' validation tools were carefully attested to make them standardized.

Data Gathering Procedure. The researcher prepared a diagnostic test to measure Grade IV pupils' ability to integrate science process skills. A pre and post-test, which include the integrated science process skills test, were validated by Master teachers, Science teachers, and English teachers, and Inquiry-Based Learning Material. After preparing the research instruments, the researcher consulted his adviser, statistician, subject specialist, and technical editor for suggestions and comments to review the instrument used.

After validating the instrument, the researcher asked permission to conduct the research. With Del Remedio Elementary School as the target, a letter addressed to the school principal was sent as a formal request to start the research. After the grant requested permission from the respective offices, the researcher conducted the study. The researcher administered the diagnostic test to assess the learning gaps with the pupils. The result showed that the pupils need an intervention in the six-process skill of science. After that, the researcher disseminated the pre-test to the pupils, and after an hour, the pretest instruments were retrieved afterward. The respondents were chosen using the sampling technique used in this study with the consideration that they are heterogeneously grouped. The class was treated using the inquiry-based learning material. With this, the pupils will undergo science learning with inquiry-based learning material during their three-week face-to-face classes.

While the tools are being executed, the pretests are checked, and the posttest will be prepared. Then, it will be given after the treatment, using the same procedure during in-person classes. Applying the same setup to check the pupil's output was executed. After gathering the data, the results were treated statistically for interpretation.

Data Analysis. All collected data will be collated for analysis. Appropriate statistical measures were used and employed to quantify the data and answer the study's problem set. Mean was used to assess the pupil's mastery of the integrated process skills and performance in science. Mean Percentage Score was used to determine the average score in the Integrated process skills test. Standard Deviation was used to get the average of how distant the individual scores are from the mean of the tests. To determine whether there are significant differences in their scores before and after the use of the strategies, a dependent samples t-test will be utilized. Inferential statistics will be tested at a five percent (5%) significance level.

III. RESULTS AND DISCUSSION

Table 1. Test of Difference between the Pre-Test and Post-test Performance in the Integrated Science Process Skills of the Respondents

Integrated Science Process Skills	Pre-test		Post-test		t	df	Sig (2-tailed)
	Mean	SD	Mean	SD			
Controlling Variables	3.3	1.363	5.55	0.639	-9.394	39	0.000
Defining Operationally	3.38	1.353	5.28	0.987	-6.696	39	0.000
Formulating Hypothesis	3.1	1.661	6.43	0.594	-11.950	39	0.000
Interpreting Data	3.05	1.413	6.43	0.636	-16.004	39	0.000
Experimenting	2.38	1.055	6.40	0.810	-21.061	39	0.000
Formulating Models	3.33	1.559	6.20	0.939	-10.265	39	0.000

Legend: $p>0.05$ not significant; $p<0.05$ significant

This study implies a significant difference between the pretest and post-test performances of the respondents who utilized Inquiry-Based learning resource material. Most of the results from the pretest fall on the level of not meeting expectations in controlling variables, defining operationally, formulating hypotheses, interpreting data, experimenting, and formulating models. During the pre-test, experimenting got the lowest mean (mean=2.38), followed by interpreting data (mean= 3.05), formulating hypothesis (mean= 3.1), controlling variable (mean= 3.3), formulating models (mean= 3.33) and the defining operationally (mean= 3.38) got the highest score. These findings show that the respondents' competence level is really poor. This means that the pupils had the least knowledge of integrated science process skills before implementing the learning resource material.

As a result, the respondents are believed to have equal proficiency levels in the various skills in the pretest. This could be deduced from the fact that their performances may differ because pupils are grouped in varied groups as mandated by the Department of Education. However, their classroom settings may be somewhat equal in terms of performance. This is related to the problem faced by the educators in the Philippines as they were alarmed by country's Trends in International Mathematics and Science Study (TIMSS) rankings. There is a significant problem in science education after placing 42nd out of 46 nations at the secondary level and 23rd out of 25 countries at the elementary level (Torregoza & Aliazas, 2024).

After utilizing the material, most of the pupils exhibited an outstanding and satisfactory level. The result shows that formulating hypothesis and interpreting data got the highest mean (mean 4.44) and implied that it is the most learned integrated science process skills with the respondents, it was followed by experimenting (mean= 6.40), the next skill gained is the formulating models (mean=6.20), the controlling variable and the defining operationally are considered to be the least gained skill (mean= 5.55 and 5.28 consecutively) which concluded that the pupils find some difficulty in stating the variables that affect their observations.

Research has shown that developing and integrating process skills in science education can positively impact student performance and achievement (Zorlu & Sezek, 2020). A study by Zhou et al. (2022) found that integrating process skills into science inquiry activities improved students' scientific knowledge and process skills. The table also showed that defining operational results had the lowest significant difference of -6.696; next is controlling variables (t= -9.394), formulating models (t=10.265), formulating hypothesis (t= 11.950), interpreting data (t= 16.004) and the greatest skill that showed significant difference is the experimenting (t=-21.061). This explained that after exposure to the learning material, the pupils mostly gained knowledge of this skill. They are exposed to different experimental setups.

A study by Yoon et al. (2012) found that explicit instruction and guidance in controlling variables positively impacted student performance in science investigations. The study also found that students who received this instruction were better able to design and conduct experiments that controlled for variables. Defining operational definitions is another important process skill that is critical to the development of scientific inquiry. A study by Didion et al. (2020) found that explicit instruction on operational definitions improved student performance in science investigations. The study also found that students who received this instruction were better able to design experiments that controlled for variables and were better able to make meaningful comparisons between data sets.

Formulating hypotheses is another important process skill that is critical to scientific inquiry. A study by Vorholzer et al. (2020) found that explicitly teaching students how to formulate hypotheses improved their ability to generate and test hypotheses in science investigations. The study also found that students who received this instruction could better design experiments that tested their hypotheses. Interpreting data is an important process skill that is critical to the development of scientific inquiry. A study by Kwangmuang et al. (2021) found that explicit instruction in data interpretation improved students' ability to interpret data and draw conclusions from scientific investigations. Experimenting and formulating models are also important process skills that are critical to scientific inquiry. A study by Wolpert-Gawron (2017) found that integrating experimentation and modeling activities into science instruction improved students' ability to design experiments and formulate and revise models based on data.

These studies suggest that the development and integration of process skills in science education can positively impact student performance and achievement. Explicit instruction and guidance in controlling variables, defining operational definitions, formulating hypotheses, interpreting data, experimenting, and formulating models can improve students' scientific knowledge and process skills, leading to better academic performance and scientific literacy (Ekici & Erdem, 2020).

In connection with this result, it is also evident from the findings of Lati (2012) that students who participated in inquiry-based activities to develop their science process skills performed higher on their posttests than on their pretests. According to Arantika et al. (2019), students' comprehension of scientific facts or their scientific predictions can be built through inquiry-based learning, which also helps them develop their experimental abilities.

Cairns and Areepattamannil (2019) concluded that science instruction emphasizes inquiry-based learning. Along with comprehending the fundamentals of science and how it affects society, students must understand and develop the science process skills. Students of all ages prefer learning science through an inquiry-based approach; however, caution must be made when implementing inquiry-based learning methodologies because the consequences on academic performance might be significant.

It can be observed that after the acquisition of integrated science process skills, the mean scores of the respondents improved. The study's findings correspond with those of earlier studies, such as those by Feyziolu (2009), who discovered a positive, significant, and linear relationship between students' effective laboratory use and their science process skills and academic achievement.

Similarly, this study lends credence to the findings of Ping et al. (2020), who discovered that SPS-trained pupils outperformed non-trained pupils in terms of success. Derilo (2019) indicated that teaching pupils scientific process skills improved their academic performance. Similar findings demonstrate that the student's success levels increased after the SPS instruction in science classes.

Idul and Caro (2022) also showed a positive relationship between SPS and academic success in science courses. Additionally, this study discovered a strong correlation between attitudes toward science and inquiry-based science instruction. This broadly aligns with prior research and underlines the beneficial effects on attitudes of a hands-on, activity-based, inquiry-based teaching strategy.

Table 2.1. Validation Result for Developed Material as to Graphic Layout and Design

Indicators	Mean	Std. Deviation	Interpretation
1. Clarity of the letters and colors	4.90	0.32	Highly acceptable
2. Precision of the sentence layout in the printed paper	4.90	0.32	Highly acceptable
3. Spacing and margins are aligned	4.90	0.32	Highly acceptable
Overall	4.90	0.31	Highly acceptable

Legend: 4.50 – 5.00 Highly acceptable; 3.50 – 4.49 Acceptable; 2.50 – 3.49 Fairly acceptable;1.50 – 2.49 Poorly acceptable; 1.00 – 1.49 Not acceptable

Table 2.1 shows the validation result for the developed material in terms of graphic layout and design. The clarity of the letters and colors (mean=4.90), precision of the sentence layout in the printed paper (mean=4.90) and spacing and margins aligned (mean=4.90) got a “highly acceptable” rating from the validators.

The importance of graphic layout and design in creating learning resources can be attributed to their contribution to the content's improved readability and visual appeal. A well-designed resource can encourage pupils to interact with the content and improve their memory. Additionally, the researcher used an effective graphic design to make difficult concepts easier to understand and increase the content's accessibility for readers with various learning preferences.

Table 2.2. Validation Result for Developed Material as to Construction

Indicators	Mean	Std. Deviation	Interpretation
1. Conformity of topic to MELC	5.00	0.00	Highly acceptable
2. Conformity of question items with indicators	4.90	0.32	Highly acceptable
3. Conformity of indicators with aspects measured	4.90	0.32	Highly acceptable

Overall	4.93	0.25	Highly acceptable

Legend: 4.50 – 5.00 Highly acceptable; 3.50 – 4.49 Acceptable; 2.50 – 3.49 Fairly acceptable;1.50 – 2.49 Poorly acceptable; 1.00 – 1.49 Not acceptable

Table 2.2 shows the validation result for the developed material in terms of construction. The topic's conformity to MELC (mean=5.00), question items' conformity with indicators (mean= 4.90), and indicators' conformity with aspects measured (mean= 4. 90) got a "highly acceptable" rating from the validators. The overall mean is 4.93.

Construction is essential when creating learning resources because it might affect the materials' usability and durability. Poorly made learning materials could not last over time and would need to be updated frequently, which can be expensive and time-consuming.

Additionally, poorly made products may be difficult to use or not work as intended, making it more difficult for pupils to connect with the subject matter. The researchers consider the factual concepts that the learner's time will use. The constructed material is adapted to the pupils' ability, making it easier to understand without omitting any parts they should learn.

Table 2.3. Validation Result for Developed Material as to Language

Indicators	Mean	Std. Deviation	Interpretation
1. Use of correct language rules	5.00	0.00	Highly acceptable
2. Simplicity of language	5.00	0.00	Highly acceptable
3. Ease of proper interpretation	4.90	0.32	Highly acceptable
Overall	4.97	0.18	Highly acceptable

Legend: 4.50 – 5.00 Highly acceptable; 3.50 – 4.49 Acceptable; 2.50 – 3.49 Fairly acceptable;1.50 – 2.49 Poorly acceptable; 1.00 – 1.49 Not acceptable

Table 2.3 reveals the validation result for developed material regarding language. The overall mean of 4.97 indicates that the indicators are "highly acceptable" based on the validators' rating, namely the use of correct language rules (mean=5.00), simplicity of language (mean=5.00), and ease of proper interpretation (mean=4.90).

Language is a significant factor in making learning resources because it can affect both the accessibility and the efficacy of the materials. Learning tools not written in a language that pupils can comprehend could be challenging or ineffective in assisting pupils in meeting their learning objectives. Learning materials not sensitive to cultural differences or acceptable for pupils' backgrounds may also fail to connect with pupils and engage them in the subject matter.

The researchers made the material sensitive to the pupils' needs. The learning resource used language that can be comprehended by Grade IV Pupils. The pupils' backgrounds and cultural differences were also considered to make this material useful.

Table 2.4. Validation Result for Developed Material as to Content

Indicators	Mean	Std. Deviation	Interpretation
1. The test items are relevant to the competencies	5.00	0.00	Highly acceptable
2. The test items are aligned to the period of teaching	5.00	0.00	Highly acceptable
3. The test questions are supported by the indicators of the study	5.00	0.00	Highly acceptable
Overall	5.00	0.00	Highly acceptable

Legend: 4.50 – 5.00 Highly acceptable; 3.50 – 4.49 Acceptable; 2.50 – 3.49 Fairly acceptable;1.50 – 2.49 Poorly acceptable; 1.00 – 1.49 Not acceptable

Table 2.4 shows the validation result for the content of the developed material. The test items are relevant to the competencies (mean=5.00), aligned to the teaching period (mean=5.00), and supported by the study indicators (mean=5.00). The test questions received a "highly acceptable" rating from the validators.

Making learning resources with content in mind is important because it can influence how well the materials support pupils in achieving their learning objectives. Learning materials that are poorly designed or lack accurate or pertinent information may not be successful in assisting pupils in comprehending the subject matter or applying it in practical settings. Additionally, it may be difficult for pupils to remain motivated and interested in the subject matter if their learning resources are not motivating or resonate with them. Likewise, the researchers focused on the learning competency in the 3rd quarter. In this way, the pupils will remain motivated and interested in the science subject. As per the researcher's observation, the pupils find science to be a boring subject.

IV. CONCLUSIONS

The respondents' scores in the pretest improved after implementing the inquiry-based learning material. There is a considerable difference between the scores of the responders in the pretest and post-test. Therefore, it may be inferred that scores improve after being exposed to Inquiry-Based Learning Material. The use of inquiry-based learning material successfully fosters the development of integrated science process abilities. This is confirmed by the results of tests conducted among the participants when the material is used appropriately with the students. It is strongly recommended that the learning material be utilized and experimented with to cultivate further skills.

The researcher employed a written assessment consisting of multiple-choice questions. It is recommended that alternative performance-based assessments, supplemented with a rubric, be utilized to gauge the proficiency of integrated science process abilities. The development of the learning resource material, namely the material provided in each lesson chapter, should be pursued due to the teacher's strong excitement for assisting Science learning.

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