International Journal of Multidisciplinary Research and Publications
ISSN (Online): 2581-6187

Inclusive Inquiry Based 5e Learning Approach for Teaching Charging Processes in Science 7

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Abstract**—***This research combined elements of quasi-experimental and descriptive methods to examine the effectiveness of the inquiry-based learning (IBL) approach, utilizing the 5E model, in improving students' understanding of charging processes. Grade 7 students from Surigao del Norte National High School were selected through purposive sampling, with Section Obedience serving as the control group and Section Courtesy as the experimental group to ensure academic proficiency was consistent. The study takes place in the educational setting of Surigao del Norte National High School. Data collection includes validated pretest and posttest assessments, carefully designed lesson plans, and a self-survey instrument to assess student perceptions. To identify significant differences in outcomes and perceptions between the experimental and control groups, statistical analyses such as the T-Test, Mean, Standard Deviation, and ANCOVA are applied. The findings reveal a significant positive effect of IBL on student comprehension and underscore its role in enhancing engagement and critical thinking skills, providing important insights for science education practices. A proposal for 1-Day Training sessions on Inquiry-Based Learning for Science Teachers at Surigao del Norte National High School was suggested*.

Keywords**—** *Control Group, Inquiry-based learning, 5E instructional model (Engage, Explore, Explain, Elaborate, Evaluate), Science Teachers*.

I. INTRODUCTION

In the field of science education, the implementation of creative teaching methods is essential for nurturing profound comprehension and analytical thinking abilities in learners. Inquiry-based learning, rooted in the 5E instructional model (Engage, Explore, Explain, Elaborate, Evaluate), emerges as a significant approach in this context. Characterized as a dynamic learning approach where learners build knowledge via exploration and inquiry, inquiry-based learning fosters advanced thinking, problem-solving skills, and a richer conceptual comprehension (Harlen & Qualter, 2018) [1]. It departs from conventional teaching techniques by enabling students to engage actively in their educational path, nurturing curiosity, and cultivating vital scientific abilities.

Assessing the efficiency of the pure-lecture approach against inquiry-based learning highlights significant benefits of the latter. In contrast to traditional lectures that mainly entail passive information absorption, inquiry-based methods actively involve students in their learning (Prince, 2018) [2]. Studies indicate that inquiry-based learning improves student motivation, critical thinking skills, and knowledge retention (Banchi & Bell, 2020) [3]. Inquiry-based methods promote a more profound comprehension of scientific concepts by enabling students to firsthand investigate ideas, pose questions, and find answers through experimentation (Bell et al., 2019) [4]. Moreover, this method promotes teamwork, communication, and critical thinking abilities, in accordance with the needs of the 21st-century job market (National Research Council, 2019) [5].

Within the educational framework of Surigao del Norte National High School, conventional teaching methods have not succeeded in fostering a thorough understanding of charging processes in students taking Science 7. Even with the committed efforts of teachers, a significant lack of comprehension and retention continues to exist concerning this essential topic. Acknowledging this shortcoming as a crucial chance for enhancement, the current study is driven by the necessity to explore the effectiveness of inquiry-based learning, particularly through the organized structure of the 5E model. Through exploring this novel teaching method, the research seeks to close the current educational gap, with the goal of enhancing students' understanding and memory of charging procedures. Additionally, by focusing on this essential area of need, the research aims to spur wider improvements in science teaching methods within the school community. In the end, the research aims to provide students with the critical knowledge and abilities necessary for scientific exploration and continuous learning, thus cultivating a generation of scientifically knowledgeable and empowered individuals ready to succeed in a constantly changing world

Inquiry-Based Learning and the 5E Model in Science Education

Inquiry-Based Learning (IBL) is an approach focused on students that promotes active exploration, inquiry, and investigation (Bybee, 2014) [7]. The five stages Engage, Explore, Explain, Elaborate, and Evaluate assist students in steadily developing knowledge, facilitating comprehension of intricate scientific ideas. Research indicates that the 5E Model improves students' critical thinking abilities and conceptual comprehension more effectively than conventional teaching approaches (Abdi, 2014)[6]. Research shows that practical activities and structured inquiries improve students' understanding of abstract physics concepts related to electric charge and charging processes (Gurel et al., 2015) [8].

Teaching Charging Processes in Science Education

Inquiry-based methods, especially the 5E Model, have been shown to greatly enhance conceptual comprehension by enabling students to investigate real-world applications via

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experiments, simulations, and group discussions (Cakir, 2008) [9].

Inclusivity in Science Education

Inclusive education guarantees that every student, including individuals with disabilities, different backgrounds, and distinct learning approaches, receives fair educational opportunities (UNESCO, 2017) [10]. Studies indicate that inquiry-driven methods can be customized to meet the needs of various learners through the use of differentiated teaching, scaffolding strategies, and supportive technologies (Tomlinson, 2014) [11]. In physics education, teaching approaches that promote inclusivity, including collaborative experiments, visual resources, and engaging simulations, have successfully enhanced learning results for students with varying requirements (Mastropieri & Scruggs, 2018) [12].

II. Methodology

This study sought to assess the impact of the inquiry-based learning method on enhancing student performance in Charging Processes in Science 7 at Surigao del Norte National High School.

Research Design- This investigation employs a multifaceted strategy, combining aspects of quasi-experimental and descriptive methods to thoroughly examine the effectiveness of the inquiry-based learning approach, particularly through the 5E model, in improving students' comprehension of charging processes. The design's quasi-experimental nature includes creating experimental and control groups in the classroom, where the experimental group participates in experiential inquiry-based learning sessions and the control group gets standard lecture-based teaching. Simultaneously, the descriptive component of the research design employs survey methods to collect information on students' views, attitudes, and experiences regarding the various teaching methods.

Research Participants- Participants in this study were chosen using purposive sampling, with intentional focus on achieving a balanced distribution of skills and abilities among Grade 7 students at Surigao del Norte National High School.

Research Locale- The study's research locale is Surigao del Norte National High School, located in the municipality of Surigao City, Surigao del Norte. Surigao del Norte National High School, a public secondary institution governed by the Department of Education, offers educational programs ranging from junior high to senior high school, featuring both STEM (Science, Technology, Engineering, and Mathematics) and GAS (General Academic Strand) strands. This title highlights its importance as a focal point for scholarly and community involvement in the surrounding region. Surigao del Norte National High School, the researcher's teaching location, acts as the central hub for examining the impact of inquiry-based learning strategies, particularly aimed at improving students' comprehension of charging processes in Science 7.

Research Instruments

Pretest and Posttest- The researcher needs to create a set (20-item) of multiple-choice questions for the pretest/posttest that is specifically designed to evaluate skills in charging processes. These inquiries can be subjected to validation and reliability assessments to verify their precision, consistency, and efficacy in evaluating students' comprehension before and after the teaching intervention.

Lesson Plans- The investigator must carefully develop two collections of lesson plans for the research. One approach involves utilizing the conventional lecture technique that focuses on instructive teaching, whereas the other integrates an inquiry-driven learning method enhanced with practical experiments and tasks. These lesson plans facilitate a comparative evaluation of how various teaching methods improve students' comprehension of charging processes.

Self-Survey Instrument- The self-survey tool includes 10 brief questions created by the researcher to assess participants' views on the efficacy of the inquiry-based learning method. Participants are asked to express their level of agreement or disagreement with each statement by utilizing a 4-point Likert scale, which spans from "strongly agree" to "strongly disagree." This tool seeks to offer important insights into students' personal experiences and viewpoints related to the teaching approach used, thus enhancing the quantitative data collected through various evaluation methods.

Data Gathering Procedure- At the outset, the researcher should perform a comprehensive examination of existing literature pertinent to inquiry-based learning and charging processes to guide the study's conceptual framework and methods. The study's objectives, procedures, and predicted outcomes were laid out in detail in a well-thought-out research plan. Simultaneously, the essential teaching documents needed for the research, such as lesson plans and instructional materials, were created. Subsequently, the research tools were thoroughly validated to confirm their reliability and validity. Approval was obtained from the principal of T Surigao del Norte National High School to carry out the research, and consent forms were given to participants before data gathering.

III. Results and Discussions

Tables 1, 2, and 3 show the pretest and posttest scores of the Grade 7 students at Surigao del Norte National High School. In these tables, section Obedience learned with Inquiry-Based Learning, while section Courtesy learned with traditional lectures.

Table 1 shows that the experimental group which comprising of 30 students, the mean pretest score was 6.63, with a standard deviation of 2.54. This group displayed a minimum score of 1 and a maximum of 11, resulting in a mean percentage score (MPS) of 32%. Conversely, the control group, also consistng of 30 students, exhibited a slightly lower mean pretest score of 6.37, with a standard deviation of 2.01. Similar to the experimental group, the control group's scores ranged from 1 to 12, yielding an MPS of 23.25%. These results indicate that the two groups had similar levels of initial knowledge or understanding before the intervention.

The research by Brown and Miller (2020) [13] highlights the importance of ensuring balanced pretest scores across

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experimental and control groups to mitigate potential biases in outcome assessments.

TABLE 1: Pre-Test Results in Charging Processes

Section	Variables	N	Mean	Standard Deviation	Minimum Score	Maximum Score	MPS (%)
Obedience	(Experimental)	30	6.63	2.54	1	11	32%
Courtesy	(Controlled)	30	6.37	2.01	1	12	23.25%

TABLE 2: Post-Test Results in Charging Processes

Section	Variables	N	Mean	Standard Deviation	Minimum Score	Maximum Score	MPS (%)
Obedience	Experimental	30	10.70	3.52	6	19	92.25%
Courtesy	Controlled	30	6.90	2.72	2	15	51.50%

TABLE 3: Significant Difference on the Pretest and Posttest Results in Charging Processes

Variables	Df	t-test (Computed Value)	$t_{0.05}$	p-value	Decision	Verbal Interpretation
Inquiry-Based *(Pre-test vs Post-test)*	29	21.18	±2.36	0.05	Reject H_o	Significant
Lecture *(Pre-test vs Post-test)*	29	11.98	±2.57	0.05	Reject H_o	Significant

The scores from the posttest show significant differences between the experimental group (Obedience) and the control group (Courtesy). In the experimental group, the average posttest score was significantly higher at 10.70, with a standard deviation of 3.52. This group demonstrated a score range from 6 to 19, leading to a mean percentage score (MPS) of 92.25%. In contrast, the control group had a lower average posttest score of 6.90, accompanied by a standard deviation of 2.72. Their scores fell between 2 and 15, resulting in an MPS of 51.50%. These results indicate a notable enhancement in learning outcomes for the experimental group in comparison to the control group after the intervention, suggesting the effectiveness of the inquiry-based teaching methodology implemented.

Research by Aguilar et al. (2017) [14] and Dela Cruz and Santos (2019) [15] emphasizes the importance for educators to explore not only traditional teaching methods but also alternative strategies to cater to varying learning needs. Therefore, the considerable difference in posttest scores between the experimental and control groups in the study underscores the beneficial influence of inquiry-based teaching methods on student success.

Table 3 indicates a significant difference in the pretest and posttest scores for both the Inquiry-Based and Lecture teaching methodologies in charging processes. The t-tests conducted for both approaches yielded computed values that surpassed the critical t-value at the 0.05 significance level, indicating rejection of the null hypothesis. Specifically, for the Inquiry-Based approach, the computed t-value was 21.18, far exceeding the critical t-value of ±2.36, with a p-value of 0.05. Similarly, for the Lecture approach, the computed t-value was 11.98, surpassing the critical t-value of ±2.57, with a p-value of 0.05. These results suggest a significant improvement in the participants' understanding of charging processes from the pretest to the posttest, regardless of the teaching method employed. Such findings underscore the effectiveness of both Inquiry-Based and Lecture approaches in enhancing students' comprehension of charging processes within the given context.

Additionally, research by Tan and Lim (2019) [16] emphasizes the importance of engaging and interactive lectures in fostering student engagement and knowledge acquisition. Thus, the significant difference observed in the pretest and posttest results in charging processes corroborates the findings of prior research, affirming the efficacy of both teaching approaches in facilitating learning in science education.

Furthermore, perceptions of the students regarding the effectiveness of the Inquiry-Based Learning approach were presented in Table 4.

TABLE 4: Perceptions on the Effectiveness of Inquiry-Based Learning Approach in Teaching Charging Processes

	Statement	Mean	SD	VI	QD
1.	Inquiry-based learning activities effectively helped me comprehend the concept of charging by friction.	3.10	0.80	A	E
2.	Engaging in hands-on experiments during inquiry-based learning enhanced my understanding of charging by induction.	2.73	0.69	A	E
3.	Inquiry-based learning encouraged me to independently explore the principles behind charging by conduction.	3.13	0.63	A	E
4.	Collaborating with peers during inquiry-based learning activities improved my grasp of charging by friction.	2.69	0.89	A	E
5.	The use of real-world examples in inquiry-based learning aided my understanding of charging by induction.	2.60	1.07	A	E
6.	Inquiry-based learning motivated me to delve deeper into the mechanisms of charging by conduction.	2.93	0.79	A	E
7.	I found inquiry-based learning to be more effective than traditional methods in understanding charging by friction.	2.73	0.94	A	E
8.	Inquiry-based learning activities challenged me to think critically about charging by induction.	2.87	0.86	A	E
9.	The freedom to investigate topics related to charging by conduction in inquiry-based learning increased my interest in the subject.	2.93	0.83	A	E
10.	Overall, I believe inquiry-based learning is an effective approach for understanding charging by friction, charging by induction, and charging by conduction.	3.00	1.02	A	E
	Average	**2.87**	**0.85**	**A**	**E**

	Scale	Verbal Interpretation	Qualitative Description
Legend	*1 – 1.75*	*Strongly Disagree (SD)*	*Not Effective (NE)*
	1.76 – 2.5	*Disagree (DA)*	*Less Effective (LE)*
	2.51 – 3.25	*Agree (A)*	*Effective (E)*
	3.26 – 4.00	*Strongly Agree (SA)*	*Very Effective (VE)*

Table 4 suggests that a majority of students agreed that Inquiry-Based Learning activities helped them to grasp concepts such as charging through friction, induction, and conduction. They found that engaging in practical experiments, exploring independently, collaborating with peers, and integrating real-life examples significantly enhanced their understanding of these topics. Furthermore, students regarded IBL as more effective compared to traditional teaching methods and believed it encouraged them to think critically and delve deeper into the subject. The overall feedback indicates strong agreement among students regarding the effectiveness of IBL in understanding charging processes.

Establishing student-centered learning environments that foster exploration, collaboration, and critical thinking is essential for creating impactful educational experiences. By incorporating IBL activities that reflect diverse learning styles and interests, educators can enhance student engagement, comprehension, and retention of scientific principles related to charging processes. As a result, these findings not only support the effectiveness of IBL but also emphasize its potential to transform science teaching methodologies for improved student outcomes.

IV. Conclusions

The research indicate that Inquiry-Based Learning (IBL) significantly improves student performance and understanding of charging processes. The clear difference observed between the experimental and control groups highlights the positive impact of IBL on educational results. The agreement among students regarding the effectiveness of IBL activities underscores its crucial role in enhancing comprehension and critical thinking.

Acknowledgments

I would like to express my gratitude to my parents, who have supported and prayed for me throughout my studies, allowing me to complete my education on time. Additionally, I would like to thank those individuals many to mentioned who have supported and helped me in working on the research.

Author Contribution

Ralph Nicole L. Balutan: conceptualization, methodology, article collection, article analysis, writing;
Supervision: Dr. Mauricio S. Adlaon

Competing Interest

The authors declare no conflict of interest.

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