ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 10| Issue: 8| August2024|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2024: 8.402 || ISI Value: 1.188

THE INFLUENCE OF INQUIRY-BASED LEARNING ON INTEGRATED SCIENCE PROCESS SKILLS OF COLLEGE STUDENTS IN TAGUM CITY: BASIS FOR AN INTERVENTION PLAN

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Article DOI: https://doi.org/10.36713/epra18107
DOI No: 10.36713/epra18107

ABSTRACT

The study aimed to determine the influence of inquiry-based learning on integrated science process skills. The result of the study was used to craft an intervention plan that will help enhance science process skills among college students. A descriptive-correlational design was employed. The 249 college-level respondents, enrolled in laboratory courses, were selected through stratified random sampling from four schools and universities in Tagum City. The study used two adapted and validated research questionnaires. Mean, standard deviation, Pearson r, and linear regression analysis were used as the statistical treatment of the study. The overall mean on the level of inquiry-based learning has resulted in 4.49 with a standard deviation of 0.67. The descriptive equivalent for the level of inquiry-based learning is very high. The homogeneity of responses has a computed standard deviation of 24.39 and a moderate descriptive equivalent which means that the indicator science process skills is fairly manifested. The result revealed that there is no significant relationship between inquiry-based learning and science process skills among college students in Tagum City. Based on the study results, an intervention plan has been developed to enhance students' integrated science process skills. This plan includes strategies for teachers to promote integrated science process skills among students, such as alternative teaching methods, targeted skill development, teacher training, curriculum integration, assessment and feedback mechanisms, student engagement techniques, and ensuring resource availability.

KEYWORDS: *Science Education, inquiry-based learning, integrated science process skills, descriptive and correlational design, Tagum City, Davao del Norte, Philippines*

INTRODUCTION

In the science learning process, students' science process skills have not grown to their full potential (Ernawati et al., 2021). Science instructors must give integrated science process skills development top priority to promote students' critical thinking and help them draw conclusions that are consistent with scientific principles. (Muzzazinah et al., 2020). Furthermore, college students must have a firm grasp of integrated science process skills because doing experiments is essential to science education (Idris et al., 2022).

In Turkey by Fugarasti et al. (2019), only 56% of the 75 questions about integrated science process skills were correctly answered by college students, indicating a need for further development of their integrated science process skills. Furthermore, according to a study conducted at one Indonesian university, instructors failed to include integrated science process skills in their lectures, which is why college students' science process abilities were rated as low with a percentage of 44 (Tahir, 2019). Additionally, the results for Malaysian university students showed a mean score range of 7.5–9.6, meaning that the respondents could not correctly answer 50% of the questions out of 40 total number of items, about integrated science process skills and could not pass the test because they have low understanding of integrated science process skills (Kamarudin et al., 2022).

One of the Universities in Leyte has attained the lowest percentage of 35.97%, in the integrated science process skills test among college students. Furthermore, the student's scores fell short of the ideal passing level in all indicators of integrated science process skills. (Libres, 2019). Another study by Barosa (2018) at a Manila university revealed that college student exam scores ranged from 20.40% to 46.67%, indicating that the results are poor and that an intervention is required to improve the integrated science process skills. In separate investigation, it was discovered that Los Baños college students have poor integrated science process skills, with means of 16.69 and 16.84 for the control and experimental groups, respectively out of 40 total number of items (Guevara, 2023).

In a study by Cabande et al. (2021) in one of the universities in Tagum City, it was noted that there is a growing concern about the low proficiency levels of integrated science process among college students in this locality as shown in their performances in class and laboratory activities. In addition, the findings of the study of Zabala and Dayaganon (2023), conducted in Davao City, Philippines, demonstrated how the integrated science process skills of the college students were inadequately developed, as evidenced by their lack of competence and reliance on their instructor to conduct laboratory activities.

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A review on literatures reveals that one of the factors that may contribute to integrated science process skills is inquiry-based learning used in education setting (Biswal & Behera, 2023; Ekici & Erdem, 2020; Nunaki et al., 2020). There were already studies which involve the connection between the said variables (Nunaki et al., 2020; Sahintepe et al., 2021; Mulyeni et al., 2019). However, the indicators employed for inquiry-based learning were different from those previously mentioned, and the study participants in the aforementioned research are international students. Furthermore, no previous research involving these two factors has been reported in the locale, and no studies that give an intervention plan that links the two variables—inquiry-based learning and integrated science process abilities have been completed yet. This study examines the influence of inquiry-based learning on integrated science process skills of college students in Tagum City as basis for an intervention plan.

Integrated science process skills of college students are crucial in understanding bigger concepts in science. Blended learning only recently transitioned back to face-to-face classes, leading to stagnation of these skills for years due to students' inability to perform laboratory activities during the pandemic.The urgent concerns about the low integrated science process skills of college students motivate the researcher to conduct the study to find the gaps through scientific investigation of the variable inquiry- based learning that contributes to the integrated science process skills of college students in Tagum City. It is essential to comprehend how contemporary teaching methodologies, such as inquiry-based learning, affect college students' integrated science process skills considering that if this problem will not be addressed, students will have difficulty in applying these skills in their fields later on.

This study examines the influence of inquiry-based learning on the integrated science process skills of college students in Tagum City and aims to assist educators by providing an intervention plan to support and enhance these skills through innovative strategies. The results of this study will provide data-driven solutions to the administrations in order to improved integrated science process skills and inquiry-based learning. Findings of the study will be shared by submitting a copy of the article to the graduate school office, the school library, and through presentations at fora and research conferences both national and international. For the benefit of upcoming researchers, the work will also be published.

RESEARCH QUESTION

This study aimed to determine the influence between integrated science process skills and inquiry-based learning practices of college students in Tagum City and develop an intervention plan based on the findings of the study.

Specifically, this study sought to answers the following questions:

1. What is the level of inquiry-based learning of college students in Tagum City in terms of:
   1.1. student participation;
   1.2. paying attention to ideas;
   1.3. collaborations;
   1.4. learning;
   1.5. asking questions;
   1.6. observation; and
   1.7. focusing on problems?
2. What is the level of integrated science process skills of college students in Tagum City in terms of:
   2.1. identifying and controlling variable;
   2.2. stating hypothesis;
   2.3. operational definitions;
   2.4. graphing and interpreting data; and
   2.5. experimental design?
3. Is there a significant relationship between inquiry-based learning and integrated science process skills?
4. Does inquiry-based learning significantly influence integrated science process skills?
5. What intervention plan can be created based on the findings of the study?

HYPOTHESIS

The following are the hypotheses were tested at 0.05 level of significance.

1. There is no significant relationship between inquiry-based learning and integrated science process skills of college students in Tagum City.
2. Inquiry-based learning does not significantly influence integrated science process skills.

METHODS

This quantitative study utilized descriptive correlational design. To accomplish the study goal, the researcher will employ this design to ascertain and accurately characterize the respondent degrees of integrated science process skills and the degree of inquiry-based learning. Multiple choice tests and survey questionnaires will be employed in the research to get numerical data from the respondents. On the other hand, correlational research is used to determine to test and determine the existing relationships of the variables of this study. The goal of how inquiry-based learning greatly influences integrated science process skills is also explored.

The respondents in this study are college students enrolled in science courses with laboratories for the academic year 2023–2024 at the four Tagum City schools or universities that are chosen. The researcher determined the sample size using the Online Raosoft Sample Size Calculator, which has a 95% confidence level and a 5% margin of error. A sample size of 249 respondents was computed from the estimated 700 college students enrolled in the four schools or universities.

To determine how many students will be randomly chosen for each school or university, the stratified random sampling technique will be employed. A sampling method called stratified random sampling divides a population into smaller subgroups known as strata (Williams, 2023). The four institutions or colleges that were chosen for this study made up the four strata. The sample size per stratum is determined through ratio and proportion to determine that School A, with estimated 200 students, had 71 student responders, School B, with estimated 200 students, had 71 student responders, School C, with estimated 150 students, had 54 student responders and School D, with estimated 150 students, had 53 student

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responders.

RESEARCH INSTRUMENTS

Two survey questionnaires were purposively chosen and adapted to collect data that answered the research questions of the study. To ensure content validity, the study tools undergoes validation by experts in the field of study. After incorporating suggestions of validator, the tools undergo pilot testing to ensure that it is reliable to be used in the study.

Inquiry-based Learning Environment Scale (IBLE). This questionnaire developed by Sarıoğlan (2021) was used in the study to measure the variable, inquiry-based learning. The adapted validated questionnaire has 40 items that are divided into seven indicators: student participation (7 items), Paying attention to ideas (6 items), collaboration (7 items), learning (5 items), asking questions (5 items), observation (5 items), and focusing on problems (5 items). This instrument undergone factor analysis for validity and reliability. The value of the Cronbach alpha for the total scale based on the pilot testing was 0.815 indicating that it has adequate reliability. On a five-point Likert scale, participants will rate their level of agreement with each statement (with 1 indicating strong disagreement and 5 indicating strong agreement). The following parameter limits, descriptive equivalents, and interpretation will be considered during the interpretation of results.

Test of Integrated Science Process Skills. This instrument was developed by Monica (2005) to measure the level of science process skills of the students. This multiple- choice questionnaire has 30 items in total that is separated into five indicators which are identifying and controlling variables (7 items), stating hypothesis (6 items), operational definition (6 items), graphing and interpreting data (8 items), and experimental design (3 items). The responses for multiple-choice questions will be coded with one-point for every correct answer and zero for every incorrect answers. The percentage of the test score will be computed by dividing the number of correct responses with the total number of items which is 30 and multiply it to 100. The following parameter limits, descriptive equivalents, and interpretation will be considered during the interpretation of results.

REVIEW OF RELATED LITERATURE

Integrated Science Process Skills

These are the abilities that support learning in the physical sciences, guarantee student engagement, help students grow a sense of ownership over their education, lengthen the learning process, and help students pick up research techniques and methods—in other words, they guarantee thinking and acting like scientists. Science Process Skills (SPS) are transferable skills that mirror the actions of scientists and are relevant to a wide range of sciences (Dolapcioglu & Subasi, 2022). Science process skills are foundation of scientific method and it is very important in science education (Hardianti & Permatasari, 2023).

Science process skills, or SPS, are the capacity to apply scientific methods to generate knowledge, understand, develop, and find science in order to resolve problems and provide outcomes (Rusmini & Rudiana, 2021). There are two types of science process skills: integrated science process skills (integrated SPS) and basic science process skills (basic SPS). Integrated SPS included identifying and controlling variable; stating hypothesis; operational definitions; graphing and interpreting data; and experimental design (Ahmed et al., 2023).

Students use science process skills as instruments to learn concepts and conduct investigations into the world around them. Because of this, educators must prepare their students to comprehend and use these skills in the lessons they teach (Kusuma & Rusmansyah, 2021). Several studies and research projects have recognized the importance of mastering science process skills. It is a goal to address problems and provide workable solutions (Manes et al., 2022). In contrast to teacher-centered approaches, student-centered methods in science classes were found to have a beneficial impact on students SPS (Ozge & Sulayman, 2022).

Inquiry-Based Learning

Inquiry-based learning, is an instructional strategy that promotes problem-based learning and experience learning among students which draws students in and makes connections between the classroom and the real world (Main, 2023). In the study conducted by Majeed et al. (2023), students who participated in instruction had superior science process skills than those who received traditional instruction.

The findings of the study conducted by Ekici and Erdem(2020), students who participate in inquiry-based laboratory activities have the opportunity to enhance their science process abilities and increase their retention and learning. The findings of the study conducted by Gonul and Motsu (2021) demonstrate that students in the experimental group that used inquiry- based learning made improvements in their ability to run experiments, define operationally, evaluate data, develop relationships among variables, and formulate models.

Additionally, it was discovered that the inquiry-based learning facilitates student application of the concepts they acquire—that is, their science process skills—by using questioning (Borrul & Valls, 2021). It was further asserted that subjecting pupils to challenging and comprehensive inquiry-based exercises helps them become proficient in science process skills. Furthermore, Tan et al. (2022) study stressed the benefits of inquiry-based learning, which can be even more effective depending on the subject matter and aids in improving student conceptual knowledge and scientific process.

In addition, students can use the inquiry-based learning paradigm to investigate, forecast, experiment, and make decisions by conducting independent investigation on science-based issues and challenges (Panjaitan, 2020). In response to the verdicts of Baharom and Atan (2020), it is strongly advised that scientific training be enhanced with technology devices through the use of an inquiry-based science education strategy. This would help students better comprehend science process skills. According to Wale and Bishaw's (2020) research, inquiry-based learning entails gathering data, conducting research, and formulating questions. There was a noteworthy distinction in the experimental and control groups' general,

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high-level, and integrated SPS levels after receiving instruction utilizing the inquiry-based learning.

The results of the study of Biswal and Behera (2023), show that inquiry-based learning improves students scientific process skills. The inquiry-based learning provides students with learning opportunities that are enriched by all-encompassing perspectives from their environment. Students thus have the chance to take part in real- world activities that support the growth of science process abilities. Additionally, it excels at helping student study both independently and during class activities. Student capacity to conduct experiments and their understanding of scientific phenomena are both enhanced by inquiry-based learning

THEORETICAL FRAMEWORK

This study is based on Lev Vygotsky's social learning theory, which holds that students actively participate in the construction of their own knowledge and that learners learn effectively as active participants and not passive learners. Inquiry-based learning allows students to be active participants in learning through inquiry that will influence the students' integrated science process skills (Detel, 2001). This theory is supported in the results of the findings conducted by Sen and Vekli (2016) which stated that inquiry-based learning significantly influences integrated science process skills and the result of the study conducted by Ceylan and Gülsah (2016), stated that the inquiry-based learning positively influences integrated science process skills.

Moreover, the study conducted by Mutlu et al. (2020), supported the claims which indicates that inquiry-based learning helps in the improvement of integrated science process skills. The results of the study of Lati et al. (2012) also proves the connection of inquiry-based learning and integrated science process skills. Furthermore, in the study conducted by Sutrisno et al. (2017), they mentioned that integrated science process skills among students was improved in the implementation of the inquiry-based learning.

Linking the proposition of the various author previously presented led to the conceptualized model shown in Figure 1. The independent variable of this study is inquiry- based learning which has the indicators namely: student participation, paying attention to ideas, collaborations, learning, asking questions, observation, and focusing on problems Sarıoğlan (2021). The dependent variable is the integrated science process skills with the following subscales identifying and controlling variable, stating hypothesis, operational definitions, graphing and interpreting data, and experimental design (Monica, 2005). The results of the findings of the relationship of inquiry-based learning and science process skills will lead to the crafting of intervention plan.

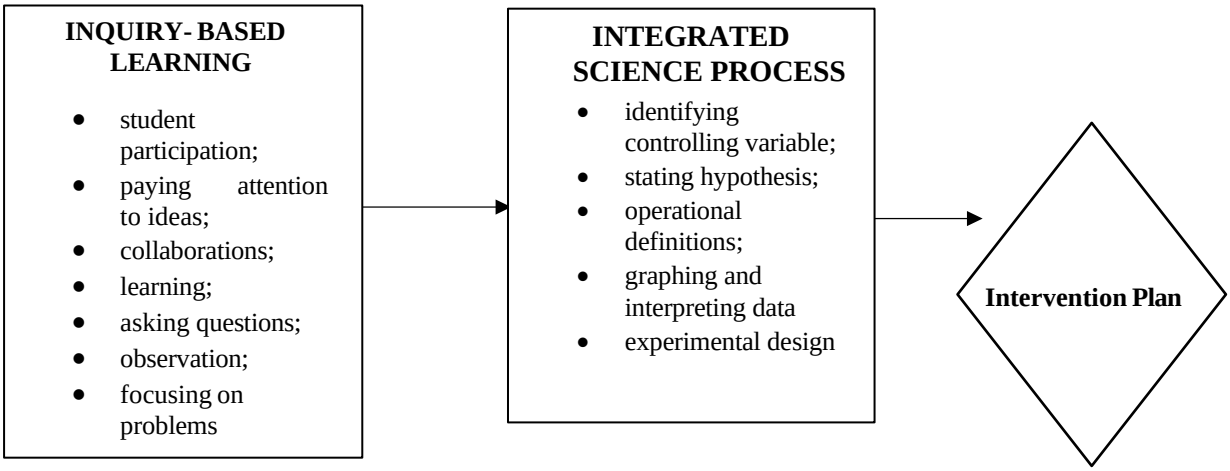


Figure 1. Conceptual Framework of the Study

RESULTS AND DISCUSSIONS

Table 1
Summary on the Level of Inquiry-based Learning

Indicators	SD	Mean	Descriptive Equivalent
Student Participation	0.68	4.47	Very High
Paying Attention to Ideas	0.64	4.59	Very High
Collaboration	0.65	4.51	Very High
Learning	0.65	4.52	Very High
Asking Questions	0.68	4.47	Very High
Observation	0.66	4.48	Very High
Focusing on Problems	0.71	4.36	Very High
Overall Mean	**0.67**	**4.49**	Very High

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The overall mean based on table 8 has resulted in 4.49 with a standard deviation of 0.67. The descriptive equivalent for inquiry-based learning is very high. The summary of the level of inquiry-based learning of the college student Tagum city in is very much evident based on the responses. This suggests that inquiry-based learning engages students through exploration and insightful questioning, fostering real-world connections. It also highlights a student-centered approach that prioritizes questioning and scientific inquiry techniques. The standard deviation of 0.67 (SD 1.00) indicates that the rating of the respondents is closer to the mean which means that the responses are almost the same.

This result is similar to the study of Biswal and Behera (2023), show that inquiry- based learning is strongly evident wherein it provides students with learning opportunities that are enriched by all-encompassing perspectives from their environment. Another similar results in the study of Wale and Bishaw's (2020) research, inquiry-based learning entails gathering data, conducting research, and formulating questions. In addition, students can use the inquiry-based learning paradigm to investigate, forecast, experiment, and make decisions by conducting independent investigation on science-based issues and challenges (Panjaitan, 2020).

There is also a plainly noticeable inquiry-based learning in the study of Ekici and Erdem, (2020) as reflected on the students who participate in inquiry-based laboratory activities. The readily apparent result on the level of inquiry-based learning according to Tan et al. (2020) is when student is subjected to a challenging and comprehensive inquiry-based exercises that facilitates student application of the concepts they acquire. In the study conducted by Majeed et al. (2023), students who participated in inquiry-based learning had a very much evident result than those who received traditional instruction

Table 2
Level of Science Process Skills

Indicators	SD	Mean	Descriptive Equivalent
Identifying and Controlling Variable	28.47	62.65	High
Stating Hypothesis	20.85	41.63	Moderate
Operational Definitions	26.61	43.24	Moderate
Graphing and Interpreting Data	23.39	34.59	Low
Experimental Design	25.60	31.59	Low
Overall Mean	**24.98**	**42.74**	Moderate

The level of integrated science process skills of college students has an overall mean of 42.74 and a descriptive equivalent of moderate. It indicates that integrated science process skills are fairly manifested. It emphasizes students' development of essential competencies such as identifying variables, formulating hypotheses, defining operations, graphing and interpreting data, and designing experiments within the framework of scientific learning is reasonably displayed. A standard deviation of 24.98 indicates that the rating of the respondents is clustered to the mean which means that the responses are homogenous, highlighting the indicator stating the hypothesis with a standard deviation of 20.85 with a close level of dimension of the science process skills.

The study of Fugarasti et al. (2019), also have a fairly manifested result of their study. The results shows that only few of the questions were answered correctly by the college students. Similar results were also highlighted in the study of Kamarudin et al. (2022), it was further explained that this result was because there is a need to demonstrate a higher level of performance in the basic science process skills as these are necessary to develop more complex integrated science process skills which are required the for the learning and understanding of the content at higher levels.

The level of integrated science process skills in the study of Jardinico and Linaugo (2023) shows that is moderate and fairly manifested among college students. Students use science process skills as instruments to learn concepts and conduct investigations into the world around them. Because of this, educators must prepare their students to comprehend and use these skills in the lessons they teach (Kusuma & Rusmansyah, 2021)

Table 3
Relationship Between Inquiry-based Learning and Science Process Skills

Variables Correlated	r-value	p-value	Remarks	Decision
Inquiry Based Learning and Science Process Skills	0.008	0.902	Not Significant	Null hypothesis is rejected

The relationship of inquiry-based learning and science process skills is also not significant in the study of Nurhayati et al. (2021). Another study conducted by Li et al. (2024) results shows that there is no significant relationship between the variables inquiry-based learning and science process skills. Integrated science process skills are foundation of scientific method and it is very important in science education (Hardianti & Permatasari, 2023).

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However, studies of Biswal and Behera (2023) shows that there is a significant relationship among inquiry-based learning and science process skills which is thought to be opposite to the result of this study which is no significant relationship. Same is true with the Sahintepe (2020) showing a relationship between two variables.

Table 3
The Influence of Inquiry-based Learning on Integrated Science Process Skills

Independent Variable	Unstandardized Coefficients		Standardized Coefficients	t	p-value	Remarks
	B	Std. Error	Beta			
(Constant)	40.687	11.076		3.673	.000	
Student Participation	-1.986	3.352	-.060	-.593	.554	Not Significant
Paying Attention to Ideas	6.133	3.636	.191	1.687	.093	Not Significant
Collaboration	.208	4.576	.006	.045	.964	Not Significant
Learning	3.674	3.447	.113	1.066	.288	Not Significant
Asking Questions	-3.852	3.502	-.117	-1.100	.272	Not Significant
Observation	2.798	3.722	.093	.752	.453	Not Significant
Focusing on Problems	-6.886	3.262	-.224	-2.111	.036	Significant
R = 0.194;	R square = .038;		F = 1.351;	p = .227		

Regression analysis is predicated on the existence of a relationship between the variables, so we do not move forward with it in the event that the result of the study show that there is no significant relationship between inquiry-based learning and science process skills. When two variables have no correlation that is, a correlation coefficient that is close to zero, it implies that changes in inquiry-based learning do not predict changes in the other variable which is science process skills. Correlation assesses the strength and direction of this linear link. Any regression model that tries to fit a line to data points that do not show any pattern is unproductive and deceptive without a substantial association, and it will produce results that are not valid.

This can be supported by the Pal and Bharati (2019) which states that regression analysis comes after correlation. The basic correlation coefficient, which indicates the strength of a linear link between two variables, is the first idea to grasp. To determine whether there is a linear relationship between the two variables, a scatter plot should be created. The square of the simple correlation coefficient can be used to gauge how well the linear regression fits the data

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Volume: 10| Issue: 8| August2024|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2024: 8.402 || ISI Value: 1.188

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