IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 4, June 2026
Impact Factor: 8.2

Evaluating the Effectiveness of Hands-On Laboratory Activities on the Academic Performance of First-Year Computer Science Students

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Abstract: *The present study determined the effects of laboratory activities on the academic performance of freshman year Computer Science students in Surigao del Norte State University. In this case, the researchers utilized a quantitative descriptive-correlational method with the aid of a structured survey questionnaire as instrument distributed among 44 participants chosen by means of simple random sampling technique. Frequency distribution, weighted mean, and Pearson Product-Moment Correlation Coefficient were used to analyze data. Based on the results, it can be concluded that majority of the students agreed that laboratory activities improve their grasp of the subject matter in programming, coding, logic, problem solving, and academic performance, as reflected by the overall weighted mean score of 3.15. Moreover, correlation analysis showed significant positive relationship between the number of laboratory sessions per week, difficulty of tasks, percentage of completed tasks, and academic performance indicators ($p < 0.05$).*

Keywords: Evaluating the Effectiveness of Hands-On Laboratory Activities on the Academic Performance of First-Year Computer Science Students.

I. INTRODUCTION

A shift towards a computer science program can pose several educational issues for students who have to switch their thinking from general concepts to concrete practices. While lecture classes provide an essential foundation, students frequently become disengaged and experience high dropout rates during the first year (Uhanova et al., 2023). In order to resolve these problems and foster academic achievements, the involvement of practical elements of study, particularly laboratory classes, became indispensable.

Indeed, laboratories can be regarded as the backbone of practice-oriented approaches in which learners get a chance to combine the knowledge they receive from theoretical lessons with concrete application. The use of laboratory classes helps to improve the level of understanding of the topic by applying it in actual situations and fixing possible mistakes in a timely manner (Osijirin et al., 2025). Moreover, empirical data prove that students who attended laboratory sessions demonstrated better exam results compared to students who received purely lecture classes, with lower dropout and failure rates (Hsiao et al., 2022). The aim of this research is to examine laboratory classes' influence on the academic achievements of students during their first year of computer science study..

Objectives of the Study

This study aims to evaluate the effectiveness of hands-on laboratory activities on the academic performance of first-year Bachelor of Science in Computer Science students at Surigao del Norte State University.

Specifically, it seeks to:

1. Determine the effectiveness of hands-on laboratory activities in improving students' technical assessment performance.
2. Determine the effectiveness of hands-on laboratory activities in enhancing students' problem-solving skills.
3. Determine the effectiveness of hands-on laboratory activities in improving students' overall academic performance.
4. Determine whether there is a significant relationship between hands-on laboratory activities and students' academic performance

II. REVIEW OF RELATED LITERATURE

The hands-on laboratory activities are an integral part of Computer Science education since they help learners to implement theoretical knowledge using practical experience. Laboratory exercises facilitate the acquisition of coding skills, development of computational and problem-solving abilities. According to Hsiao et al. (2022), active participation in programming exercises helps achieve greater learning success and academic performance. Additionally, such practical experience increases learner confidence when addressing programming issues and facilitates the comprehension of complex theoretical concepts.

Active Learning Techniques Active learning methods involve the active involvement of learners in the learning process through collaboration, experimentation, and engaging with different tasks. Nguyen et al. (2021) noted that active learning techniques have a positive effect on engagement, cognitive development, and learning performance among students. The researchers emphasized that active engagement is associated with greater academic achievements and improved learning.

Programming Exercises and Skill Building Regular practice of programming leads to the improvement of coding skills and development of learners' logical thinking. Hsiao et al. (2022) stated that regular programming practice has a positive impact on learning performance and enhances students' motivation. The continuous implementation of practical exercises allows acquiring advanced programming and computational skills.

Learners' Perception of Learning Activities The students' perception of learning activities' relevance affects learners' motivation and academic success. Su et al. (2022) stated that programming activities viewed by learners as meaningful lead to the increased level of engagement and effectiveness of learning. The positive attitude towards the tasks motivates learners to actively participate in educational activities.

Problem-Solving Abilities and Academic Performance The problem-solving skills are crucial for programming education. Cheah (2022) described programming novices' difficulties in comprehending programming principles but pointed out that consistent practice can eliminate them. The skill of problem-solving is essential for academic performance and professional growth of students.

Synthesis

There is evidence from the reviewed literature suggesting that laboratory work and active learning play a role in helping students perform better academically, enhancing their skills in programming and their capacity to solve problems. Laboratory experiences create chances for students to apply theory, enhance coding skills, and become confident in carrying out different technical assignments. This justifies the research that is aimed at establishing the efficacy of laboratory work on academic performance of Computer Science freshmen.

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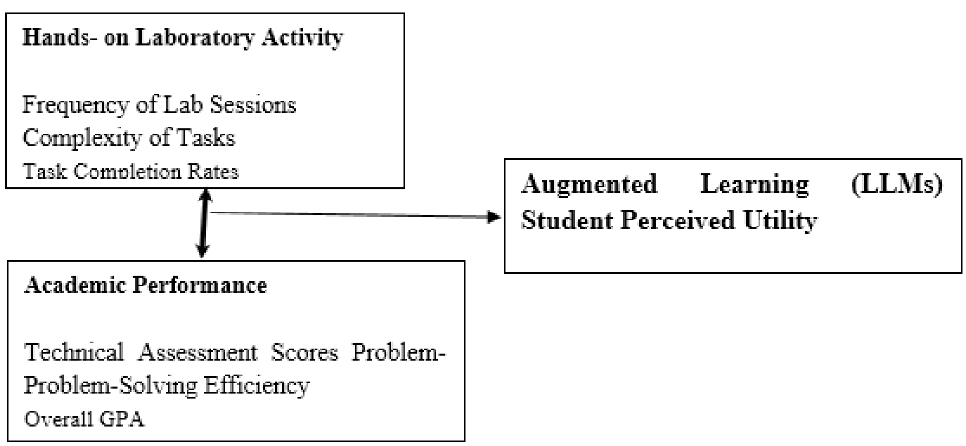
III. RESEARCH METHODOLOGY

This chapter outlines the research design, data collection techniques, and analysis methods used in the study. It is written with enough detail to allow for replication of the research process.

CONCEPTUAL FRAMEWORK

The present research is based on the hypothesis that particular laboratory-related operational parameters affect the academic outcomes of first-year Computer Science students. In particular, these include frequency of practice, complexity of assignments, and speed of task completion by students. The aforementioned independent variables should impact the dependent one (academic outcomes) through the moderating effect exerted by modern learning tools and perceptions.

The conceptual framework of this study is organized into three variable categories. The independent variables, which serve as the primary inputs, include the frequency of lab sessions, referring to the regularity and consistency of scheduled practice sessions designed to provide students with sustained exposure to coding software (Astin, 2025); the complexity of tasks, which pertains to the calculated difficulty level of laboratory exercises intended to foster algorithmic thinking (Benin, 2025); and task completion rates, which measure students' capacity to successfully finish assigned laboratory modules (Miller & Chen, 2026). The moderating variables, which function as influencing factors, consist of augmented learning through Large Language Models (LLMs), encompassing real-time assistance provided by artificial intelligence tools for debugging and concept clarification (Zdravkova & Ilijoski, 2025); and perceived student utility, defined as students' subjective assessment of the relevance of laboratory practices and tools to their future career success (Huang & Wang, 2025). Finally, the dependent variables, representing the measurable outcomes of the study, include technical assessment scores, derived from coding examinations and practical technical assessments (Hsiao et al., 2022); problem-solving efforts, which reflect students' ability to address complex coding challenges encompassing both logical and syntactic dimensions (Ngadengon et al., 2025); and Grade Point Average (GPA), serving as a broader indicator of overall academic achievement among Computer Science majors (Oguntibeju, 2026).



Research Design

This study will assessed the impact of practical laboratory exercises on first-year computer science students' academic performance using a descriptive-correlational research approach. While the correlational method ascertain whether there is a significant association between students' academic achievement and hands-on laboratory activities, the descriptive method was used to characterize the students' perceptions and experiences about laboratory activities.

The independent variable is Hands-on Laboratory Activity. Hands-on activities are considered the core link in developing a CS student's practical and innovative ability. Literature from 2021 onwards stresses that there is no substitute for the retention of technical facts other than direct experience.

This research design is suitable because it enables the researchers to determine how practical laboratory exercises affect students' learning, engagement, skill development, and general academic achievement..

Population and Sampling

The respondents consisted of first-year Bachelor of Science in Computer Science students enrolled at Surigao del Norte State University during Academic Year 2025–2026 who participated in hands-on laboratory activities.

The respondents were selected randomly from the list of Computer Science students enrolled at Surigao del Norte State University – main campus during the academic year 2025–2026.The following criteria must be met in the selection process of respondents:

- Must be currently enrolled as a computer science student at SNSU – main campus.
- Must be taking programming subjects
- Must have Hands-On Laboratory Activities

Simple random sampling is appropriate since it offers an equal chance to all eligible students to participate in the study.

Data Collection

The researchers used a structured survey questionnaire as the primary instrument for data collection. The questionnaire will be distributed through Google Forms for convenience and accessibility.

The questionnaire was used to gather quantitative data regarding the effectiveness of hands-on laboratory activities and their influence on the academic performance of the students.

The survey link was distributed through online communication platforms such as Messenger, school group chats, or email.

Data Analysis

The collected data were analyzed using the following statistical tools:

Frequency and Percentage Distribution

This was used to describe the profile of respondents and summarize their responses regarding programming the effectiveness of hands-on laboratory activities.

Weighted Mean

This was used to measure the average responses of participants regarding the effectiveness of hands-on laboratory activities and the academic performance. The weighted mean was used interpreted using the following scale:

Scale of Interpretation for Likert Responses

Scale	Range	Verbal Description	Interpretation
4	3.50 – 4.00	Strongly Agree	Very High
3	2.50 – 3.49	Agree	High / Moderate
2	1.50 – 2.49	Disagree	Low
1	1.00 – 1.49	Strongly Disagree	Very Low

Pearson Product-Moment Correlation Coefficient (Pearson r)

This statistical tool was used to determine whether there is a significant relationship between the independent variables(frequency of lab session, complexity of task, and task completion rates) and the dependent variables (technical assessment scores, overall GPA, and problem solving Efficiency).

Pearson correlation will help identify the strength and direction of the relationship between variables. The level of significance will be set at 0.05, where a p-value less than 0.05 will indicate a statistically significant relationship.

The gathered data will be processed and analyzed using statistical software to ensure accuracy and reliability of the results. The findings will be interpreted according to the study objectives and used as the basis for conclusions and recommendations.

IV. RESULTS AND DISCUSSION

The findings of the study based on the survey administered to 44 Computer Science students at Surigao Del Norte State University (SNSU), are discussed in this chapter.The gathered data were analyzed using frequency count, percentage, and weighted mean to determine the effectiveness of hands-on laboratory activities on the academic performance of the respondents. The results are presented in tabular form followed by corresponding interpretations.

AGE DISTRIBUTION OF RESPONDENTS

TABLE 1. AGE DISTRIBUTION OF RESPONDENTS

AGE	FREQUENCY (F)	PERCENTAGE (%)
19 YEARS OLD	**40**	**90.9%**
20YEARS OLD	**2**	**4.55%**
21YEARS OLD	**2**	**4.55%**
TOTAL	**44**	**100%**

The Data indicates that the vast majority of the freshman respondents (90.9%) belong to the 19 years old category. This suggests a group of learners who are navigating their first year of the computer science curriculum at a consistent developmental stage.

DISTRIBUTION BY SEX

TABLE 2. SEX DISTRIBUTION OF RESPONDENTS

GENDER	FREQUENCY (F)	PERCENTAGE (%)
MALE	**23**	**52.3%**
FEMALE	**21**	**47.7%**
TOTAL	**44**	**100%**

4.2 Impact of Hands-On Laboratory Activities on Students' Academic Skills and Performance

4.2.3 Level of Frequency of Lab Session

Table 3. Level of Frequency of laboratory Sessions

No.	Technical Assessment Scores	Mean	Interpretation
1	I achieve higher scores in technical assessments.	2.977272727	Agree
2	Hands-on laboratory activities help me understand programming concepts better.	3.113636364	Agree

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3	Hands-on laboratory activities help improve my coding skills.	3.227272727	Agree
	Overall GPA		
4	It contributes to improving my overall GPA.	3.136363636	Agree
5	Hands-on laboratory activities help me perform better in my subjects.	3.159090909	Agree
6	It positively affects my academic performance.	3.318181818	Agree
	Problem Solving Efficiency		
7	Hands-on laboratory activities improve my ability to solve programming problems.	3.113636364	Agree
8	It makes me more efficient in solving tasks.	3.159090909	Agree
9	Hands-on laboratory activities enhance my logical thinking skills.	3.181818182	Agree
	Overall Mean	3.154040404	Agree

Table 3 The results clearly show that the subjects are convinced that regular attendance in laboratory classes is very beneficial for their performance in academics and the skill set of programming. Laboratory work offers continuous chances to put the theories learned in practical sessions and improve one's abilities to code logically and effectively. With laboratory sessions, students learn to solve programming problems regularly, which boosts their confidence and ability to solve issues in programming. Overall, the findings suggest that increased regularity in laboratory classes is associated with higher performance and learning, resulting in success both academically and technically in Computer Science.

4.2.4 Complexity of Task

Table 4. Complexity of Tasks

No.	Technical Assessment Scores	Mean	Interpretation
1	Helps improve my performance in technical assessments.	2.977272727	Agree
2	Challenges me to think critically and solve problems.	3.113636364	Agree
3	Enhances my understanding of complex programming topics.	3.227272727	Agree
	Overall GPA		
4	Contributes positively to my overall GPA.	3.136363636	Agree
5	Improves my logical thinking skills.	3.159090909	Agree
6	Helps me become more efficient in solving coding problems.	3.318181818	Agree
	Problem Solving Efficiency		
7	Motivates me to learn more advanced concepts.	3.113636364	Agree

8	Strengthens my ability to analyze and fix errors.	3.159090909	Agree
9	Encourages me to explore different approaches in solving problems.	3.181818182	Agree
	Overall Mean	3.154040404	Agree

Table 4 The findings indicate that there is a consensus among the respondents that the level of difficulty in laboratory tasks positively impacts their learning and academic achievements. Increasingly difficult laboratory tasks make the learners employ critical thinking, analytical reasoning skills, and systematic problem-solving strategies. Difficult assignments allow the learners to be exposed to many coding scenarios, which help them master algorithm and logical skills. It is evident from the findings that carefully designed laboratory assignments aid in fostering deep learning among the learners. This implies that designing increasing levels of laboratory assignments helps students master the necessary programming skills. Consequently, laboratory tasks with increasing levels of difficulty can assist in building the technical skills of learners, which will enable them to take advanced Computer Science subjects..

4.2.5 Task Completion Rates

Table 5. Task Completion Rates

No.	Technical Assessment Scores	Mean	Interpretation
1	Helps me perform better in technical assessments.	2.977272727	Agree
2	Improves my time management skills.	3.113636364	Agree
3	Increases my confidence in coding.	3.227272727	Agree
	Overall GPA		
4	Contributes to a better overall GPA.	3.136363636	Agree
5	Allows me to practice and understand lessons more deeply.	3.159090909	Agree
6	Completing laboratory activities improves my confidence in solving programming problems independently.	3.318181818	Agree
	Problem Solving Efficiency		
7	Helps me stay focused and organized in my work.	3.113636364	Agree
8	Prepares me for real-world programming tasks.	3.159090909	Agree
9	Develops discipline and consistency in completing academic responsibilities.	3.181818182	Agree
	Overall Mean	3.154040404	Agree

Table 5 As shown by the results, the timely completion of laboratory activities enhances the academic performance and programming capabilities of students. Those students who are able to accomplish laboratory tasks effectively will find themselves better disciplined, more punctual, and able to think logically and solve programming problems effectively.

The average value of all answers indicates that students recognize the importance of completing tasks in improving their practical knowledge of programming. It is in line with research on experiential learning which stresses the necessity of repetition and involvement in order to learn successfully.

4.3 Relationship Between Variables

Table 6. Correlation Matrix: Laboratory Factors vs. Academic Performance

Independent Variable	Pearson r	p-value	Interpretation	Decision
Frequency of Lab Sessions	0.941	< .001	Significant	**Reject (H_0)**
Complexity of Task	0.952	< .001	Significant	**Reject (H_0)**
Task Completion Rates	0.938	< .001	Significant	**Reject (H_0)**

Based on the statistical analysis, all p-values are less than the 0.05 level of significance. Therefore, the Null Hypothesis **(H_0) is REJECTED.** This indicates that there is a significant relationship between hands-on laboratory factors and the academic performance of first-year Computer Science students. The very strong r values suggest that as the regularity of sessions, the challenge of the tasks, and the rate of completion increase, the students' technical assessment scores, GPA, and problem-solving efficiency improve significantly.

V. CONCLUSIONS AND RECOMMENDATIONS

This study entitled “Evaluating the Effectiveness of Hands-On Laboratory Activities on the Academic Performance of First-Year Computer Science Students” was conducted to determine the effectiveness of hands-on laboratory activities in relation to students’ academic performance and learning development.The conclusions are based on the results obtained from the analysis of the collected data from the responses of 44 participants who took part in the survey. Recommendations are also provided for the benefit of students, teachers, university administrators, and researchers.

5.1 Conclusions

The following conclusions were derived from the key findings presented in Chapter 4:

5.1.1 Profile of the Respondents

The sample was largely composed of 19-year-old students (90.9%), indicating that the respondents were predominantly first-year Computer Science students enrolled in programming courses. An almost equal ratio between male (52.3%) and female (47.7%) participants suggests that the results obtained from this study can be considered representative for both genders taking the Computer Science course.

5.1.1 Impact of Hands-On Laboratory Activities on Students’ Academic Skills and Performance

The effectiveness of hands-on laboratory activities on the academic performance of first-year Computer Science students. The results reveal that the respondents generally agree that hands-on laboratory activities help improve their programming concepts, coding skills, logical thinking skills, and overall academic performance.

The indicator “contributes to a better overall GPA” received the lowest weighted mean and is interpreted as Agree, suggesting that while laboratory activities improve skills and understanding, their direct impact on GPA is less pronounced.

Overall, the findings imply that hands-on laboratory activities are highly effective in improving students' learning outcomes, technical competence, and readiness for real-world programming tasks among first-year Computer Science students.

Recommendations

Students should actively participate in laboratory activities to further improve their programming and analytical skills.
More structured and guided laboratory exercises should be implemented to maximize learning outcomes.
Future researchers may conduct similar studies with a larger population or compare different programs to further validate the effectiveness of laboratory activities.

VI. ACKNOWLEDGMENT

The researchers would like to express their sincere gratitude to Surigao del Norte State University, the College of Computing and Information Sciences, their research adviser, faculty members, and the respondents who participated in this study. The researchers also extend their appreciation to their families and friends for their continuous support, encouragement, and understanding throughout the completion of this research.

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