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STUDENTS' SCIENCE PROCESS SKILLS, LEARNING ENVIRONMENT AND ATTITUDE IN A THERMODYNAMIC LABORATORY THROUGH SCAFFOLDED INSTRUCTION

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ABSTRACT

Teaching science entails more than just imparting scientific knowledge; teachers must create an appropriate learning environment to increase student interest while developing skills that can be applied in real-life situations. Consequently, the purpose of this research is to determine the extent and relationship of students' science process skills, learning environment, and attitude in a thermodynamics laboratory through scaffolded instruction. A descriptive correlational research design was used in this study. To gather the data, eighty (80) third-year science education students were chosen using total enumeration sampling and given two adapted questionnaires. The study's findings revealed that students' science process skills were moderately practiced, and a favorable learning environment was also moderately practiced in a thermodynamics laboratory under scaffolded instruction. Likewise, a positive attitude toward inquiry and enjoyment was found. Finally, the null hypothesis was rejected because there is a significant relationship between students' science process skills, learning environment, and attitude. This implies that mastering science process skills and improving the learning environment in a thermodynamic laboratory would increase student interest in the subject matter. As a result, the study recommends that instructors may foster a conducive learning environment and develop students' science process skills to improve students' attitude towards the course. To fully explore the effectiveness of scaffolded instruction, the study also suggests implementing the "I do, we do, you do" strategy to learners in a different field of study and compare the students' pre and post-test scores.

Keywords: *Science process skills, learning environment, attitude, scaffolded instruction, thermodynamic*

INTRODUCTION

Teaching science involves more than just promoting scientific knowledge. Understanding the fundamental concepts of thermodynamics, the physical field of science that deals with the laws governing energy flow and transformation (Haddad, 2017), is well-known to be difficult. Students must therefore integrate skills, knowledge, and attitudes through a scaffolded instruction laboratory environment to better understand these concepts.

Together with the abstract nature of the topics, instructor-centered pedagogical methods, a lack of student motivation, and negative attitudes about physical chemistry influenced low performance in the thermodynamics course. A study had also made mention of students' poor basic science process skills and positive but insufficient attitudes (Kamba et al., 2018). Likewise, students have reportedly expressed dissatisfaction with their physics teachers' teaching methods in the classroom (Dah, 2022).

With regards to the aforementioned concerns, it is necessary to introduce students to a strategy that eventually allows them control over the learning process. Using scaffolded instruction, specifically “I do, We do, You do” strategy, students in a laboratory class experience explicit instruction and modeling, followed by supervised laboratory activities, and finally independent demonstration of one's own design activity. This would help students develop their process skills and improve laboratory learning environments which will in turn result in a positive attitude toward thermodynamics.

To date, a study that looked into the students' science process skills and attitudes has determined that while most students have extremely positive attitudes, not all of them are proficient in science process skills (Mirana, 2019). Moreover, Zeidan and Jayosi's (2014) study showed that there was a significant positive relationship between science process skills and attitude, with a correlation coefficient of 0.69. This implies that student's interest in science increases as they gain a better understanding of the science process skills. Meanwhile, research states that the learning environment at school has a significant impact on students' attitude towards the subject and how well they perform academically (Ohakamike-Obeka, 2016).

The current study stands out in comparison to the previous studies due to three key differences. First, rather than analyzing two variables, the current study investigated three variables, including science process skills, learning environment and attitude. Second, the study focused more on a thermodynamics laboratory course at the university level for the students enrolled in the same instructor's class who used the same approach. Third, the study looked into scaffolded instruction particularly the "I do, We do, You do"

strategy in a thermodynamics laboratory class that has not yet been thoroughly researched.

Consequently, this study aimed to determine the extent of students' science process skills, learning environment and attitude in a thermodynamics laboratory class through scaffolded instruction. Further, this study sought to determine the relationship between the variables. Knowing this would give valuable information for enhancing the quality of the teacher-student learning process in the laboratory. The findings would also serve as a guide for future researchers who would like to do further study on the “I do, We do, You do” approach.

Research Questions

The study examined the level of science process skills, learning environment, and attitude of students in thermodynamics laboratory through scaffolded instruction at Central Mindanao University. Specifically, it sought to answer the following questions:

1. What is the level of science process skills of students enrolled in thermodynamics laboratory through scaffolded instruction?
2. What is the learning environment of students in thermodynamics laboratory through scaffolded instruction in terms of:
    a. integration,
    b. material environment,
    c. teacher support,
    d. task orientation,
    e. investigation, and
    f. differentiation?
3. What is the attitude of students enrolled in thermodynamics laboratory through scaffolded instruction in terms of:
    a. inquiry, and
    b. enjoyment?
4. Is there a significant relationship between the students’ science process skills, learning environment, and attitude?

METHODOLOGY

This study utilized a descriptive correlational research design with the aid of adapted survey questionnaires to assess the level and relationship of students' science process skills, learning environment, and attitude in a thermodynamics laboratory employing scaffolded instruction. Eighty (80) science education students enrolled in thermodynamics laboratory under scaffolded instruction from Central Mindanao University were selected as participants through total enumeration sampling. The researchers submitted an approval letter to the Dean of the College of Education before gathering the necessary data.

To facilitate the gathering of data, the participants were given two adapted questionnaires, namely: Science Process Skills Inventory (Bourdeau & Arnold, 2009) and Laboratory Assessment Questionnaires (Oser, 2013). The nature and method of the study was explained to the participants, and their consent was requested. The researchers also assured the confidentiality of all the data collected and an option to become anonymous was granted. In analyzing the data, the researcher used descriptive statistics to assess the level of students' science process skills, learning environment, and attitude. Pearson's product-moment correlation was then performed to determine the relationship between students' science process skills, learning environment, and attitude in a thermodynamics laboratory class employing scaffolded instruction.

RESULTS AND DISCUSSION

Students' Science Process Skills

Table 1. Students' science process skills

INDICATORS	MEAN	DECRIPTIVE RATING	QUALITATIVE INTERPRETATION
I can use the result of my investigation to answer the question that I asked.	3.08	Usually	Moderately Practiced
I can use data to create graph for presentation to others.	3.00	Usually	Moderately Practiced
I can record data accurately.	2.98	Usually	Moderately Practiced
I can use model to explain my results.	2.86	Usually	Moderately Practiced
I can use science terms to share my results.	2.84	Usually	Moderately Practiced
I can ask a question that can be answered by collecting.	2.81	Usually	Moderately Practiced
I can analyze the results of a scientific evaluation.	2.80	Usually	Moderately Practiced
I can create display to communicate my data and observation.	2.75	Usually	Moderately Practiced
I can use scientific knowledge to form a question.	2.64	Usually	Moderately Practiced
I can design a scientific procedure to answer a question.	2.64	Usually	Moderately Practiced
I can communicate a scientific procedure for others.	2.63	Usually	Moderately Practiced
Overall Mean	2.82	Usually	Moderately Practiced

Table 1 presents the students' science process skills in thermodynamics laboratory through scaffolded instruction. The overall mean value of 2.82 signifies that the participants "usually" performed the indicators presented, indicating these science process skills were "moderately practiced". All the indicators cited are rated as "usually" and "moderately practiced", with the highest mean score of 3.08 indicating that most students are confident in using the results of their investigations to answer their own questions. The result displays that the science process skills of third year BSE-Sciences students are moderately practiced in thermodynamics laboratory class under scaffolded instruction specifically the "I do, we do, you do" approach. The "I do, we do, you do" approach works students' science process skills, but it is still in the moderate range, so there is a need for this approach to be used more frequently with the addition of engaging activities so students can master science process skills. The findings are consistent with Fikriyah and Ahied (2022) who reported a moderate science process skills score. They pointed out that while students were able to conduct several experiments in school, the science process skills must be taught to students on a continuous basis during the course of study in order to achieve further improvement. As stated by Libata et al. (2023), promoting students' science process skills necessitated cautious and organized attention to the planning and creation of instruction. The instructions must connect to individual prior knowledge and encourage students to exchange ideas in their own words. The use of appropriate scaffolded support can assist learners who do not have a strong background in the topic as it addresses instructional goals and the needs of learners such as science process skills (Renken et al., 2015).

Students' Learning Environment

Table 2 summarizes the findings in six dimensions of learning environment in a thermodynamics laboratory class where scaffolded instruction was used. As shown in the table, the overall mean value is 3.69 indicating "moderately practiced". The integration dimension obtained the highest mean value of 4.23, indicating that integration in thermodynamics was "highly practiced" under scaffolded instruction. The differentiation dimension, on the other hand, obtained the lowest mean value of 3.15, indicating that differentiation of activities and assessment was "fairly practiced." This reveals that students gained a reasonable understanding on the concepts and principles taught in the laboratory. Through the guidance given by the instructor, students were able to complete the given laboratory experiments, and were able to create and explain the results of their personalized activity. However, students may still need some additional assistance and support from the instructor to fully grasp the concepts and apply those concepts in new scenarios or settings.

Table 2. Summary of students" learning environment

DIMENSIONS	MEAN	DESCRIPTIVE RATING	QUALITATIVE INTERPRETATION
Integration	4.23	Strongly Agree	Highly Practiced
Task Orientation	4.16	Agree	Moderately Practiced
Investigation	3.65	Agree	Moderately Practiced

Material Environment	3.56	Agree	Moderately Practiced
Teacher Support	3.39	Not Sure	Fairly Practiced
Differentiation	3.15	Not sure	Fairly Practiced
Overall Mean	3.69	Agree	Moderately Practiced

The findings agree with the findings of Odutuyi (2014), who found that the integration dimension of the chemistry laboratory learning environment also garnered the most significant effect on students' performance. Additionally, based on the study of Kandamby (2019), students who actively participate in the learning process with the guidance and assistance of the instructor before the commencement of practical, and students who observe the physical outcome of the experiment while doing investigation have showed better results.

Students' Attitude

Table 3. Summary of students' learning environment

DIMENSIONS	MEAN	DESCRIPTIVE RATING	QUALITATIVE INTERPRETATION
Enjoyment	3.75	Agree	Positive Attitude
Inquiry	3.60	Agree	Positive Attitude
Overall Mean	3.68	Agree	Positive Attitude

Table 3 summarizes the findings in two dimensions of attitude in a thermodynamics laboratory class where scaffolded instruction was used. As indicated in the table, the overall mean value is 3.68, indicating a "positive attitude." The outcome indicates that students have fun and improve their inquiry skills while performing experiments in the thermodynamics laboratory. Therefore, there is a need to encourage student engagement and inquiry in the laboratory to improve knowledge retention and skill acquisition. Given that real-life challenges do not have clear step-by-step solutions, teachers must focus on developing the curiosity that students require not only to find the answers but also to passionately discover the inquiries they must solve (Damşa & Nerland, 2016).

Relationship of students' science process skills, learning environment and attitude

Table 4. Correlation analysis between students' science process skills. learning environment and attitude.

VARIABLES	PEARSON COEFFICIENT r	SIGNIFICANCE (2 TAILED)
Science Process Skills	0.317	0.004 **
Learning Environment	0.486	0.000 **
Task Orientation	0.150	0.184 ns
Integration	0.251	0.025 *
Teacher Support	0.450	0.000**
Investigation	0.406	0.000**

Material Environment	0.542	0.000**
Differentiation	0.332	0.003**

** Correlation is significant at the 0.01 level (2-tailed)
*Correlation significant at the 0.05 level (2-tailed)

Table 4 conveys the correlational analysis of students' science process skills, learning environment and attitude in a thermodynamics laboratory under scaffolded instruction. The results of the study displayed a significant relationship between students' science process skills, learning environment, and attitude. The null hypothesis is thus rejected. Given an r value of 0.317 and a p value of 0.004, the figure above revealed a weak positive relationship between students' science process skills and attitude, which is statistically significant at the 0.01 level. This implies that as students gain mastery of science process skills, their attitudes tend to improve, although in a weak manner. Accordingly, students will find it enjoyable to conduct investigation when they are given the opportunity to observe, investigate, and interpret in the laboratory.

The outcomes supported the findings of Ihejiamaizu et al. (2020) who calculated a correlation value of 0.456 was reported, suggesting that there is a significant relationship between senior secondary biology students' attitude and science process skills. Meanwhile, Kamba (2018) discovered a strong positive correlation between attitudes toward physics and science process skills. Signifying that as students gain science process skills, physics appears more appealing to them, leading to a more favorable attitude toward physics. In addition to that, Zeidan and Jayosi's research in 2014 discovered a strong positive correlation between science process skills and attitude, with a correlation value of 0.69. This implies that students' interest in science grows as they gain greater knowledge of the scientific process.

On the other hand, the relationship between learning environment and attitude is moderately positive, as indicated by the r of 0.486 and the p value of 0.000, exhibiting statistical significance at the 0.01 level. This demonstrates that students' attitudes toward the subject are influenced by their learning environment. The result is consistent with the findings of Alarcon et al. (2022), who found that each learning environment scale had a positive and significant connection to each student's attitude. This suggests that a positive perception of one's learning environment is linked to an improved attitude in the student. Moreover, Putra et al. (2020) discovered a 0.719 Pearson correlation coefficient, indicating a relationship between learning environment and attitude towards physics subjects. Students will be more engaged throughout the learning process and are likely to retain what their teacher imparts when they are provided with a safe, comfortable, and supportive learning environment (Aini & Park, 2012).

Conclusions

The student’s science process skills (SPS) in thermodynamics laboratory through the scaffolded instruction is moderately practiced among the third-year science education students in college of education, Central Mindanao University. It is concluded that the majority of students enrolled in this subject have a moderate level of science process

skills and have developed progressive learning to a good degree.

Overall, the learning environment in thermodynamics laboratory that students experience under scaffolded instruction is moderately practiced in terms of its dimensions. However, certain aspects of the learning environment such as teacher support and differentiation require more attention from the instructor.

Moreover, dimensions of the students' attitudes in thermodynamics laboratory under scaffolded instruction showed a positive attitude. This suggests that when carrying out experiments in the thermodynamics laboratory, students have fun and become curious enough to pose questions and look for answers. For this reason, increasing student participation and inquiry in the laboratory is essential in enhancing their engagement and skill development.

Statistically it is then concluded that there is a significant relationship between the science process skills (SPS), learning environment, and attitude of the students in thermodynamics laboratory class through scaffolded instruction. This implies that enhancing the learning environment in a thermodynamic laboratory and developing science process skills will boost students' interest in the subject. Students' enthusiasm in learning would then be stimulated and they would be able to have fun while learning.

Recommendations

Based on the results and findings of the study, the researchers formulated the following recommendations:

It is recommended that instructors may continue to use the "I do, We do, You do" strategy with additional hands-on tasks to help students acquire and develop science process skills.

Instructors may also provide additional guidance, support, and activity differentiation to students in order to create a conducive laboratory learning environment.

Furthermore, instructors may want to add interesting supplementary laboratory exercises to their students while using the "I do, We do, You do" approach. These may increase students' enjoyment and curiosity in questioning and investigating.

Nonetheless, it is recommended that, while implementing the "I do, We do, You do" Strategy, the instructor may create a conducive learning environment and develops students' science process skills in order to improve students' attitude thereby enhancing their performance in class.

For future studies, future researchers may use the same strategy ("I do, we do, you do"). In order to gain additional insight into its efficacy in the cognitive, affective, and psychomotor domains, future researchers may look at the academic achievement of students while utilizing this technique in addition to their science process skills and

attitude.

Compliance with Ethical Standards

The researchers affirm that all ethical standards relevant to this research were strictly adhered to. Before the conduct of the study, the researchers obtained an Institutional Ethics Review Committee Certificate and approval from the Dean of the College of Education. Informed consent was then obtained from all participants, who were fully informed of their right to withdraw from the study at any time. Participant confidentiality and anonymity were maintained throughout the research process, with stringent measures implemented to protect their privacy and ensure data security. The welfare of all participants was prioritized, and no harm or discomfort was experienced as a result of their involvement. The study was conducted with transparency and integrity, free from any conflicts of interest. All sources and references were properly cited to recognize prior work and ensure accurate attribution. The findings were interpreted impartially and are intended solely for scholarly research purposes.

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