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Students' Problem-Solving Skills and Motivation in Guided Inquiry Laboratory Method in Thermodynamics

Aljun Cansa*, Carl Hiendrick Radovan & Arman Nuezca*****

***,** & ***Science Education Department, College of Education, Central Mindanao University, University Town, Musuan, Maramag, Bukidnon, Philippines*

ABSTRACT

The study generally aimed to determine the level of students' problem-solving skills and motivation as they are exposed to the Guided Inquiry Laboratory Method (GILM) in thermodynamics. The participants of the study were the third-year Bachelor of Secondary Education major in Sciences students enrolled in the thermodynamics class. The research utilized adapted and validated survey questionnaires in determining the students' level of problem-solving skills and motivation. A descriptive-correlational research design was employed in the study. Descriptive statistics and Pearson correlation coefficient were used in the analysis of the quantitative data.

Findings of the study revealed that students have an average level of problem-solving skills in thermodynamics when exposed to GILM. Moreover, results of the study showed that students are highly motivated to learn the subject on the following dimensions: self-efficacy, active learning strategies, science learning values, performance goal, achievement goal, and learning environment stimulation. Furthermore, the results of the study further revealed a significant positive correlation between the problem-solving skills and motivation of students in thermodynamics under the GILM learning environment.

Based on the findings of the study, the researchers concluded that students' motivation is influenced by their problem-solving skills as they are exposed to GILM in thermodynamics. Thus, teachers may consider using GILM in teaching thermodynamics and other science-related disciplines since it is found to improve students' problem-solving skills and motivation.

KEYWORDS: *guided inquiry laboratory method, thermodynamics, problem-solving skills, motivation*

INTRODUCTION

Laboratory courses nowadays, specifically in science, promote excitement for the students as they engage with the different experiments that enhance knowledge abided by experience in the learning process. Thus, the Guided Inquiry Laboratory Method (GILM), as an approach in teaching, was formulated to synthesize student capacity in laboratory field output as it obligates inquiry-based learning and experiential activities with guidance. This teaching method obligates student-centered practice, as the students' pace in learning becomes

independent. Here, the instructor only acts as the facilitator. According to Lunetta, Hofstein, and Clogh (2007), valuable laboratory experience opens up meaningful science education.
In the post-pandemic period, the guided inquiry laboratory method in the thermodynamics laboratory encourages the students to think critically, methodically, and innovatively about the laboratory activities at their own pace. GILM is a refreshment from the online classes during the pandemic period since the distant learning did not meet the students' experience that a laboratory course should have. Factors in learning such as problem-solving skills and motivation are influences in students learning process, which is a consideration in the guided inquiry laboratory method that must be measured.

Determining the effects of the guided inquiry laboratory method in thermodynamics on the students' problem-solving skills and motivation implies the effectiveness of the teaching approach. Thus, opportunities exist for future scholars to test the findings of the study in terms of the effectiveness and efficacy of the teaching method in the other dimensions of education.

Nworgu and Otum (2013) stated that when students are exposed to the guided inquiry method, there is a much more significant enhancement in their scientific processing skills than with the traditional method. When the method is utilized, students are encouraging themselves to think critically and solve problems at their own pace (Scott & Hilt, 2019). Thus, the students motivation towards the course increases, parallel to their academic achievements for science laboratory activities (Ervim, 2016).

This research study hopes to bridge the gap in the literature to answer whether the guided inquiry method would lead to improved problem-solving skills when it is in the laboratory setting. Also, observation as to how GILM affects the different dimensions of motivation would be investigated to identify learning aspects that must be considered. Thus, the study aims to identify the level of students' problem-solving skills and motivation under the GILM in thermodynamics.

STATEMENT OF THE PROBLEM

The study generally aimed to investigates students' problem-solving skills and motivation in thermodynamics in a Guided Inquiry Laboratory Method (GILM) learning environment.

Specifically, this sought to answers the following questions:

1. What is the level of students' problem-solving skills in thermodynamics when exposed to Guided Inquiry Laboratory Method (GILM)?
2. What is the level of students' motivation in thermodynamics when exposed to Guided Inquiry Laboratory Method (GILM) in terms of:
   a. self-efficacy;
   b. active learning strategies;
   c. science learning values;
   d. performance goal
   e. achievement goal; and
   f. learning environment stimulation?

3. Is there a significant relationship between students' problem-solving skills and motivation when they are exposed in Guided Inquiry Laboratory Method (GILM) in thermodynamics?

HYPOTHESIS OF THE STUDY

From the problem stated above, the hypothesis was formulated and tested at 0.01 level of significance:

H_{01}: There is no significant relationship between the students' problem-solving skills and motivation when exposed to guided inquiry laboratory method in Thermodynamics.

METHODOLOGY

The researchers employed a descriptive-correlational research design in determining the relationship between students' problem-solving skills and motivation in thermodynamics exposed to a Guided Inquiry Laboratory Method (GILM) learning environment. The study was conducted among the sixty-five (65) Bachelor of Science in Education major in Sciences students in Central Mindanao University who served as participants of the study. Furthermore, a total enumeration sampling technique was employed in selecting the participants. Moreover, the researchers utilized an adapted and modified survey questionnaire from Alegre, E., & Mingke, G. (2019) and Tuan, H.L., Chin C.C., & Shief, S.H. (2005) in measuring students level of problem-solving skills and motivation, respectively. Descriptive statistics such as mean and standard deviation were used in interpreting the quantitative data obtained from the survey questionnaires. On the other hand, the Pearson correlation coefficient was used to determine any significant relationship among the variables being investigated.

RESULTS AND DISCUSSION

Table 1. Students' Problem-solving skills in Thermodynamics under GILM

INDICATORS	MEAN	DESCRIPTION RATING	QUALITATIVE INTERPRETATION
My classmates help me in studying thermodynamics laboratory problem-solving.	3.77	Agree	Above Average
I practice solving thermodynamics laboratory problems.	3.60	Agree	Above Average
Thermodynamics laboratory problem is useful to me outside the school.	3.55	Agree	Above Average
I find it interesting in answering thermodynamics laboratory problems.	3.40	Undecided	Average
I do not know the process to be followed in solving	2.92	Undecided	Average

thermodynamics laboratory problems. (−)			
I like solving thermodynamics laboratory problems.	2.85	Undecided	Average
I do not know what operations to be used in solving thermodynamics laboratory problems. (−)	2.82	Undecided	Average
I do not like thermodynamics laboratory problems concept. (−)	2.80	Undecided	Average
I find thermodynamics laboratory boring when my teacher does not discuss problem-solving process.	2.50	Disagree	Below Average
I got low score in our quizzes in thermodynamics problem-solving. (−)	2.47	Disagree	Below Average
I find it difficult to translate thermodynamics laboratory problems. (−)	2.37	Disagree	Below Average
I am not good in thermodynamics laboratory problem-solving. (−)	2.30	Disagree	Below Average
I tend to guess the answer if I find it difficult to solve. (−)	2.15	Disagree	Below Average
I find it difficult to understand thermodynamics laboratory problems. (−)	2.07	Disagree	Below Average
I need to improve my skills in thermodynamics laboratory problem-solving. (−)	1.97	Disagree	Below Average
Over-all Mean Interpretation	2.77	Undecided	Average

Legend:

Range	Description rating	Qualitative Interpretation
4.21-5.00	Strongly Agree	Excellent
3.41-4.20	Agree	Above Average
2.61-3.40	Undecided	Average
1.81-2.60	Disagree	Below Average
1.00-1.80	Strongly Disagree	Poor

The level of students problem-solving skills in thermodynamics when exposed to the guided inquiry laboratory method is shown in Table 1. As projected in the table, an overall mean score of 2.77 indicating “undecided” was obtained. Based on the mean value, the Guided Inquiry Laboratory Method (GILM) in thermodynamics pursued an average level of problem-solving skills among the students. This result is in parallel to the findings of Cindikia et al. (2020) on the effects of the guided inquiry model on the senior high school students. Findings of their study revealed that the majority of the students are in the medium category in terms

of their problem-solving skills when exposed to such teaching methodology. They further suggest that other teaching methods may be utilized to improve problem-solving skills among the students. Moreover, the study conducted by Huang (2022) on the effectiveness of an inquiry-based laboratory for the students problem-solving found that the teaching strategy results in improved student cooperation and problem-solving skills for novice learners, while experienced learners tend to change in direction.

DIMENSIONS	MEAN	DESCRIPTION RATING	QUALITATIVE INTERPRETATION
Achievement Goal	3.90	Agree	Highly Motivated
Science Learning Values	3.76	Agree	Highly Motivated
Active Learning Strategies	3.72	Agree	Highly Motivated
Learning Environment Stimulation	3.47	Agree	Highly Motivated
Performance Goal	3.15	Undecided	Moderately Motivated
Self-efficacy	3.00	Undecided	Moderately Motivated
Over-all Mean Interpretation	3.50	Agree	Highly Motivated

Table 2. Students' Motivation in Thermodynamics under GILM

Legend:

Range	Descriptive range	Qualitative Interpretation
4.21-5.00	Strongly Agree	Extremely Motivated
3.41-4.20	Agree	Highly Motivated
2.61-3.40	Undecided	Moderately Motivated
1.81-2.60	Disagree	Poorly Motivated
1.00-1.80	Strongly Disagree	Not Motivated

Table 2 highlights the dimensions of motivation in thermodynamics. The table revealed an overall mean of 3.50, indicating "agree" on the dimensions: achievement goal, science learning values, active learning strategies, and learning environment stimulation. On the other hand, dimensions that indicate "undecided" are performance goals and self-efficacy. The findings reveal that students are highly motivated during thermodynamics laboratory sessions when they are exposed through the Guided Inquiry Laboratory Method (GILM). The findings are supported by the study of Uzezi and Zainab (2017), as they revealed that guided inquiry laboratory experiments impact students' motivation and academic performance rather than the traditional way of instruction. Under the approach, positive students scores in experiments were observed, which indicates better motivational reflection. On the same vein, Erdogan (2017) identified that when students are exposed to a guided inquiry learning environment, they tend to ask higher-order cognitive-level questions, which also indicates their motivation. The encouragement of these students also becomes higher than that of the students who were not exposed to the guided inquiry learning environment. Pratiwi et al. (2022) also denoted that guided inquiry activity learning methodologies were helpful in enhancing students' knowledge and engagement, which is a factor of motivation.

Table 3. Correlation Analysis in Students' Problem-solving skills and Motivation in Guided inquiry laboratory method in Thermodynamics under GILM

INDICATORS	CORRELATION	PROBABILITY
Motivation	0.602(**)	.000
Self-efficacy	0.779(**)	.000
Active Learning Strategy	0.367(**)	.003
Science Learning Values	0.154	.220
Performance Goal	0.155	.217
Achievement Goal	0.158	.208
Learning Environment Stimulation	0.114	.364

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

The relationship between students' problem-solving skills and motivation in terms of self-efficacy, active learning strategies, science learning values, performance goal, achievement goal, and learning environment stimulation is shown in Table 9. The six (6) sub-variables of motivation are all related to the students problem-solving skills. However, two (2) sub-variables of motivation—self-efficacy and active learning strategy entails $p<0.01$, which signifies a significant positive relationship to the students problem-solving skills. To elaborate further, self-efficacy and active learning strategy are significant at the 0.01 level. This means that the higher the self-efficacy and active learning strategy, the higher the problem-solving skills of the students. This supports the findings of Prastiwi et al. (2018), which revealed that there is a very strong relationship between the science process skills, an essential aspect to solving problems, and student learning motivation. It was concluded that a higher student score of science process skills equates to higher student learning motivation. Furthermore, Yunus et al. (2021) identified similar findings of the study, where they found a positive relationship between problem-solving abilities and achievement motivation employed by civic education teachers in higher education institutions.

CONCLUSION AND RECOMMENDATION

The researchers concluded that the students have an average level of problem-solving skills in thermodynamics when exposed to GILM. On the other hand, the level of students' motivation in terms of performance goal and self-efficacy is found to be moderately motivated. However, they are highly motivated in terms of achievement goal, science learning values, active learning strategies, and learning environment stimulation. Furthermore, there is a significant positive relationship between problem-solving skills and motivation, thus rejecting the null hypothesis of the study, which states that there is no significant relationship between students problem-solving skills and motivation in thermodynamics when exposed to GILM.

The researcher suggests that physics teachers may emphasize the students problem-solving skills by integrating teaching tools, alternative strategies, and innovations to enhance students problem-solving skills in the thermodynamics laboratory. Moreover, as the finding shows a moderate level of motivation in terms of performance goals and self-efficacy, the researcher

further suggests that physics teachers may consider practical activities to enhance students conceptual understanding and problem-solving skills. Lastly, researchers suggest that school administrators and curriculum developers may consider a variety of teaching methods that can be used in thermodynamics in order to address diverse learning styles.

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