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Thermodynamics Learning Packet As Innovative Instructional Tools To Improve Prospective Science Teachers' Achievement, Critical Thinking Disposition,Reflective Thinking Skills, And Adaptive Learning Engagement

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Abstract *This study examined the effectiveness of the developed thermodynamics learning packet as a learning instructional innovation to improve prospective science teacher achievement, critical thinking disposition, reflective thinking skills, adaptive learning engagement. This research was descriptive – evaluative research design and one-group pretest-posttest design. The study sample is purposively selected consisted of 30 female students who have difficulties in learning thermodynamics, specifically the nature of heat, ideal gases and laws of thermodynamics. The respondents ages are between 20 - 25 years old. All respondents/subject had no previous experience with the usage of using learning packet applications in thermodynamics learning. The data collection instruments included validated and adapted questionnaires and multiple-choice achievement test. The test results were analyzed using descriptive and inferential statistics. The evaluators (physics teachers and physics experts) agreed that developed thermodynamics learning packets are excellent in terms of the content, format, presentation, organization, accuracy, and up-to-date information that conforms to need of the Licensure examination for teachers and syllabus. There is significant difference on the assessment of the two groups of respondents (physics teachers and physics experts) on the level of acceptability of the developed thermodynamics learning packets.*

The results showed significant difference in prospective science teacher's achievements. It was observable that who used the developed thermodynamics learning packet showed better in their learning achievement, critical thinking disposition, reflective thinking skills and adaptive learning engagement. Thus, it can be concluded that the thermodynamics learning packets is an effective instructional material for developing prospective science teachers learning achievement, critical thinking disposition, reflective thinking skills and adaptive learning engagement. It showed that critical thinking disposition, reflective thinking and adaptive learning engagement demonstrates a positive but not statistically significant relationship to learning achievement of prospective science teachers.

Consequently, that reflective thinking and adaptive learning engagement, significantly enhance prospective science teachers critical thinking disposition. These findings also offer insights for educational practitioners in designing more innovative materials in physics courses.

More so, further review and evaluation of the developed thermodynamics learning packet may be considered to make it more contextualized, localized, and indigenized in the Philippine setting.

Keywords: *adaptive learning engagement, critical thinking disposition, developed thermodynamics learning packet, learning achievement, reflective thinking skills*

INTRODUCTION

The teacher is known as the most effective instructional material inside the classroom, but himself/herself alone could not cater to all the various needs of the students. As such, learning materials like modules, workbooks, work texts, and textbooks, among others, as partners of teachers should be considered significant in the teaching process.

Etkina, and Planinsic, (2024) mentioned that one should learn too from textbooks to substantiate the limits in the adequacy of teachers` verbal instruction. This means that learning materials are used as an aid to explain further concepts and thoughts that the teacher fails to discuss. For instance, Marnita et al (2020) claimed that these materials do not merely enrich or supplement present methods of instruction but also facilitate learning, make learning vivid, increase retention, cater to more individual differences, and eliminate verbalism. One of the most flexible learning materials to facilitate learning during asynchronous and face – to-face learning is learning packet.

The utilization of learning packet promotes independent and discovery learning. It allows learners to learn at their own pace and helps them become more responsible for their learning. When used as a supplement to face-to-face instruction, such material provides ideas and practices that frame classroom activity via text and diagrammatic representations and help teachers realize their goals that they presumably could not or would not accomplish on their own. This, among other supplemental materials, is found noteworthy in teaching, regardless of the mode of instruction (Pineda, 2020; Nurhasnah et al, 2020; Akinbadewa & Sofowora,2020; and Wahyuni et al, 2020).

Several works of literature underscored the multidimensional roles of learning packets in the acquisition of knowledge in thermodynamics. The importance of effective learning materials is highlighted in the context of fostering

21st-century skills, such as reasoning, problem-solving, and critical thinking (Aceved et al, 2020; and Risdianto et al, 2020). These skills are essential for students to navigate complex scientific concepts and real-world applications. While Risdianto et al, (2020) emphasizes skill development, it indirectly suggests that well-designed learning materials can facilitate this process by providing structured opportunities for engagement and exploration.

Moreover, an innovative learning material has been shown to enhance student adaptive learning engagement, reflective and critical thinking, offering diverse pathways for students to connect with abstract thermodynamics concepts (Liana et al, 2020; and Sambudi et al,2021).

The development of learning packet is not an easy task. It requires careful planning, critical development of its framework, and the skill to develop the module base from its framework. Because of its laborious processes, lack of creativity, teaching workload, large class size, and lack of training, teachers have negative attitudes toward instructional material improvisations (Jehadan, et al, 2020; & Rahman et al, 2024).

However, due to the sudden change in the mode of instruction due to the contagion, teachers were forced to develop instructional materials, including the learning packet, to continue delivering instruction (Romarate, 2023). However, research studies have found that unavailability is one of the significant challenges and issues among University (Rubi, 2019; Simiyu & Wanjala, 2020).

Samosa et al (2023) and Villaruz et al., (2023) stressed that various applications in laws of thermodynamics are easy to find in daily life, but there are still difficulties in learning the concept and there was confusion between heat and energy concepts because of the inadequate learning materials that simplified this thermodynamics concepts.

As faculty member it is beset with these problems, they must prioritize the urgency of demand and offer prompt and effective solutions to address this dilemma. Thus, the need to develop learning packet in the physics courses particularly thermodynamics. Literature shows the value of high-quality and appropriate instructional resources in teaching and learning which influences their effective use in the classroom (Abubakar, 2020). Further, instructional materials promote better academic performance in different courses (Yulianci et al, 2021; Susilawati et al, 2022; Daramola et al, 2023).

In a nutshell, the researcher who are faculty at education institution are convinced that developing learning packet for thermodynamics course is a critical tool for preparing competent prospective science teachers. These instructional materials are suitable for use in a flexible learning environment and face – to – face learning.

The purpose of this research paper is to address the lack of instructional materials which may enhance the needs of the teachers in the teaching- learning process and the improvement of prospective science teachers' achievement, critical thinking disposition, reflective thinking skills, adaptive learning engagement. Instructional materials such as learning packets are important for students' experiences in the university. They serve as a map for students to have a visual concept of what the curriculum looks like from the beginning until the conclusion of the subject. In this way, students are guided throughout learning process. Given the educational and technological demands of new times, high quality developed learning packet are still relevant, important and indispensable to learners' education contrary to the idea that learning materials are becoming more electronic and digitalized.

Research Problem

This study aims to evaluate the developed thermodynamics learning packet as a learning instructional innovation to improve prospective science teacher achievement, critical thinking disposition, reflective thinking skills, adaptive learning engagement.

Specifically, this study will seek answers to the following questions:

1. How may the level of acceptability of the developed thermodynamics learning packet as learning instructional innovation as assessed by experts and physics teachers in terms of:
    1.1 Content
    1.2 Format and Language
    1.3 Presentation and Organization
    1.4 Accuracy and Up-to-datedness
2. Is there significant difference in the assessment of the two groups of respondents (experts and physics teachers) on the level of acceptability of the developed thermodynamics learning packet as learning instructional innovation?
3. How effective is the developed thermodynamics learning packet as learning instructional innovation in improving the thermodynamics achievement of prospective science teachers as revealed by their pretest and post-test mean scores?
4. Is there a significant difference between the pretest and post-test mean scores of the prospective science teachers?
5. How may the level of critical thinking disposition of prospective science teachers be described in terms of:
    5.1 Open-mindedness;
    5.2 Truth seeking;

5.3 Analyticity;
5.4 Systematicity;
5.5 Self-confidence;
5.6 Inquisitiveness; and
5.7 Cognitive Maturity?

6. How may the level of reflective thinking of science prospective teachers be described in terms of:
   6.1 Self-Reflection
   6.2 Mastery;
   6.3 Feedback; and
   6.4 Realization?
7. How may the extent adaptive learning engagement of science prospective teachers be described in terms of:
   7.1 Learning goal orientation;
   7.2 Task value;
   7.3 Self-efficacy; and
   7.4 Self-regulation?
8. Does the prospective science teacher achievement as exposed to the implementation of thermodynamics learning packet significantly related to the following variables:
   8.1 critical thinking disposition;
   8.2 reflective thinking; and
   8.3 adaptive learning engagement?
9. Does the prospective science teacher critical thinking disposition as exposed to the implementation of thermodynamics learning packet significantly related to the following variables:
   9.1 reflective thinking; and
   9.2 adaptive learning engagement?

METHODOLOGY

Research Design

The study descriptive – evaluative research design and one-group pretest-posttest design.

To assess the developed thermodynamics learning packet as a learning instructional innovation, the researcher employed descriptive – evaluative research design to examine its level of acceptability in terms of content, format, language, presentation, organization, accuracy and up-to-datedness of the learning materials that be used to improve the prospective science teacher achievement, critical thinking disposition, reflective thinking skills, adaptive learning engagement.

Samosa and Dantay (2022) pointed out that descriptive-evaluative research is typically designed to describe the process, impact of the development and implementation of policies, practices, programs, intervention, remediation, innovation and learning resources. It is aimed to provide information for decision maker (policy maker) related to a power or strength of a policies, practices, programs, intervention, remediation, innovation and learning resources, seen from its effectiveness, cost, device, issues and challenges. Meanwhile, the pre-experimental type of research specifically one-group pretest-posttest design was also employed to test the effectiveness of the developed thermodynamics learning packet as a learning instructional innovation. This method was used in such a way that the group was pretested.

Afterwards, the treatment (i.e., implementation of the thermodynamics learning packet as a learning instructional innovation) were employed to the group and the posttest was administered. During this phase of the study, it examined the significant difference of the raw scores between the pretest and posttest scores. This will serve as strong evidence to prove the validity of the said developed thermodynamics learning packet as a learning instructional innovation.

Respondents

The current study was conducted in the first semester of calendar year 2024 - 2025, on the second year Bachelor of Science major in science from Cavite State University. The study sample is purposively selected consisted of 30 female students have similar traits and specific characteristics to the respondents/subjects, which are students who have difficulties in learning thermodynamics, specifically the nature of heat, ideal gases and laws of thermodynamics. The respondents ages are between 20 - 25 years old. All respondents/subject had no previous experience with the usage of using learning packet applications in thermodynamics learning.

Instruments

The instruments that will be used in this study will include the adapted learning resource material validation form, researcher – made thermodynamics achievement test (TAT), and researcher- made- checklist-survey includes critical thinking disposition, reflective thinking skills, adaptive learning engagement survey.

Learning resource validation form was adapted to Samosa and Samosa (2024) tool used to evaluate the level of acceptability in terms of content, format, language, presentation, organization, accuracy and up-to-datedness of the learning materials. This validation form has ten (10) indicators considered for each sub-variable. The reliability of the validation form was 0.91 which expressed high reliability.

Consequently, to ensure validity of the thermodynamics achievement test (TAT) and researcher- made-checklist-survey, the researcher enlisted the physics experts to examines the congruency of the instrument to answer the research problem of the study. All experts' suggestions were considered to achieve validity. The questionnaire's reliability will be tested to thirty (30) prospective science teacher non- respondents which same characteristics from the respondents/subject from those in the study.

Thermodynamics Achievement Test (TAT). The thermodynamics achievement test (TAT)was researcher-made test. It contained fifty (50) multiple choice response test. This were administered before the treatment and after the treatment. The test was used as pre – test and post-test. The thermodynamics achievement test (TAT) used to measure the learners'' ability to recall, relate, and apply any of information received during the treatment. The thermodynamics achievement test (TAT)followed the table of specification (TOS) in accordance with the licensure examination for teacher in Professional Regulation Commission (PRC), Commission of Higher Education Memorandum order (CMO no. 75 s.17) for BSED Science and syllabus in thermodynamics for the calendar year 2024 – 2025 that it was reliable and valid. It covered the topics on the nature of heat, ideal gases and laws of thermodynamics. The trial test of thermodynamics achievement test (TAT) reveals its reliability coefficient of 0.85 using Cronbach's alpha which established acceptable reliability.

The researcher- made- checklist-survey composed of three (3) parts consists of the following:

Part I focuses on the level of **critical thinking disposition** of prospective science teachers be described in terms of open-mindedness; truth seeking; analyticity; systematicity; self-confidence; inquisitiveness; and cognitive maturity with five (5) indicators for each variables considered. The Cronbach Alpha coefficients tests were 0.92, which indicates high reliability.

Part II focuses on the level of **reflective thinking** of prospective science teachers in terms of self-reflection; mastery; feedback; and realization with five (5) indicators for each variables considered. The Cronbach Alpha coefficients tests were 0.82, which indicates acceptable reliability.

Part III examines the extent adaptive learning engagement of prospective science teachers in terms of learning goal orientation; task value; self-efficacy; and self-regulation with five (5) indicators for each variables considered. The Cronbach Alpha coefficients tests were 0.90, which indicates high reliability.

Data Gathering Procedure

The data from the study were gathered using documentation procedure. This could be made possible by considering the details from the instrumentations.

Upon the approval of the final draft of the instruments by the experts, the researcher wrote a letter to the Campus Administration of Cavite State University- Naic for approval to conduct a research study. Upon the approval and endorsement of the study, the researcher will send a letter to the Teacher Education Department (TED) Chairperson of the target school.

After that the researcher consulted the BSED Science Program Head of the university for the least mastered skills in Thermodynamics for the past 2 years. After the identifying the least mastered skills, the researcher developed thermodynamics learning packet as a learning instructional innovation was written keeping in mind the difficulties encountered by the students in analyzing and solving thermodynamic problems. It contains illustrative lecture notes, organized problems with step – by – step solutions and practical sets of exercises that will be useful to prospective science teachers in the preparation for licensure examinations. After, the developed thermodynamics learning packet underwent validation from three(3) physics faculty who had masters' degree holders in Physics or Physics Education and three(3) physics experts who had doctorate degree holders in Physics or Physics Education.

Then, the researcher facilitated the following pre-assessment phase (pretest), the experiment phase (implementation of thermodynamics learning packet), and the post-assessment phase (posttest).

The Pre-Assessment Phase consists of a given pretest on the topics of the nature of heat, ideal gases and laws of thermodynamics in order to assess their level of academic performance before the conduct of the study.

The Experimental Phase is characterized by the researcher implementation of the thermodynamics learning packet to be given to the selected sixty (60) prospective science teachers. The Post – Assessment Phase consists of a given posttest on the topics of thermodynamics learning packet in order to assess their level of academic achievement after the conduct of the study. After the implementation of Post – Assessment Phase, the researchers utilized the researcher- made- checklist-survey includes critical thinking disposition, reflective thinking skills, adaptive learning engagement survey.

Finally, was the collation and tabulation of data. The researcher collated, tallied coded and tabulated all the information acquired from the respondents/subjects then analyzed and interpreted the statistical results.

Statistical Analysis

The following statistical tools were used in the treatment of data:

Weighted Mean. It is used to determine the level of acceptability of the developed thermodynamics learning packet as learning instructional innovation as assessed by experts and physics teachers. More, it describes the prospective science teacher critical thinking disposition, reflective thinking skills, adaptive learning engagement. This addresses research problem 1, 5,6, and 7.

Percentage Mean. Use to determine the mean assessment on the prospective science teachers' achievement in the pre-test and post-test scores. **Normalized Gain (Hake gain scores)** will be used to examine the change in average class scores, pre-test to post-test on the implementation of the developed thermodynamics learning packet as learning instructional innovation. This will answer problem number 3.

T-test of the dependent sample. To determine the significant difference in the assessment of the two groups of respondents (experts and physics teachers) on the level of acceptability of the developed thermodynamics learning packet as learning instructional innovation. More so, the inference of the difference in the mean scores in the pre-test and the post-test. These addresses research problem 2 and 4.

Criteria	Physics Teachers		Physics Experts		Combined	
	WM	Interpretation	WM	Interpretation	WM	Interpretation
Content	4.67	Excellent	4.73	Excellent	4.70	Excellent
Format and Language	4.53	Excellent	4.77	Excellent	4.65	Excellent
Presentation and Organization	4.47	Excellent	4.67	Excellent	4.57	Excellent
Accuracy and Up-to-datedness	4.63	Excellent	4.80	Excellent	4.72	Excellent
Overall	4.58	Excellent	4.74	Excellent	4.66	Excellent

Regression analysis will be used to estimates of some unknown parameters to describe the relationship the prospective science teacher achievement to the critical thinking disposition; reflective thinking; and adaptive learning engagement. More so, the analysis of the relationship between the prospective science teacher critical thinking disposition to the reflective thinking; and adaptive learning engagement. This address research problems number 7, and 8.

RESULTS & DISCUSSIONS

Table 1. Assessment of Physics Teachers and Physics Experts on the Acceptability of Learning Packets.

Presented on the tables were the summary of the evaluation of physics teachers and physics experts on the extent level of acceptability of the developed thermodynamics learning packets in terms of content; format and language; presentation and organization and accuracy and up-to-datedness.

The Table 1 yield the level of acceptability of the developed thermodynamics learning packets as assessed by physics teachers and physics experts. The data gathered from physics teachers' acceptability to the developed learning packets revealed that content; format and language; presentation and organization and accuracy and up-to-datedness obtained excellent based on the computed mean scores of 4.67, 4.53, 4.47, and 4.63 respectively. The overall assessments of physics teachers gained 4.58 will be interpreted as excellent. This implies that the physics teachers' validators highly agree that the developed learning packets is presented in a way that it will serve its purpose to the prospective science teacher users, it is adhered on the content; format and language; presentation and organization and accuracy and up-to-datedness.

Meanwhile, the evaluation of physics experts obtained an overall mean score of 4.74 which interpreted as excellent. Looking on the content; format and language; presentation and organization and accuracy and up-to-datedness the physics experts assessed as excellent based on the computed mean scores of 4.73, 4.77, 4.67, and 4.80 respectively. The physics experts believed that developed thermodynamics learning packets attained the needed criteria in content; format and language; presentation and organization and accuracy and up-to-datedness were helpful for students' knowledge adaptation appropriate to their level that demonstrates the mastery of essential goals and competencies of thermodynamics concepts in self-directed, self-paced, and self-monitored learning.

The combined assessments of physics teachers and physics experts was acquired an excellent validation on the following criteria in content; format and language; presentation and organization and accuracy and up-to-datedness with the mean scores of 4.70, 4.65, 4.67, 4.57, and 4.72, respectively. The overall means was 4.66 and interpreted as excellent. All evaluators agreed that developed thermodynamics learning packets are valid according to their content, format, presentation, organization, accuracy, and up-to-date information. According to the evaluators, the developed thermodynamics learning packets conforms to objectives set by Licensure examination for teachers and syllabus. Additional HOTS (Higher-order thinking skills) was integrated by means of problem-solving and activities or thought-provoking questions.

The results of Acosta, (2020) indicated that the learning materials are most effective when their content and purposes are appropriate, especially if they are validated. Proportionally, the materials created are those for which the sequence of activities was meticulously selected, crafted with specific goals, and tailored to suit a particular format and method.

Table 2. Test of difference on the Acceptability of Learning Packets by Physics Teachers and Physics Experts

Posed on the table below is the analysis on the assessment of the two groups of respondents, by physics teachers and physics experts on the level of acceptability of the developed thermodynamics learning packets**.**

The researcher utilized t-test for dependent sample to test inference and determine the significant difference on the assessment of the two groups of respondents as well as to compare groups of observations or measurements on a single characteristic and draws decision as to whether there is a significant difference present among the two sample means on a single set of scores for every variable considered.

Considerably, the conduct of the test of inference considered for the level of significance at 0.05, two-tailed with a degree of freedom (df) of 9 and the corresponding tabular t-value was ±2.26.

Criteria	df	t-test computed value	t-test critical value	P – value	Decision	Interpretation
Content	9	-0.39	±2.26	0.70	Ho is accepted	Not Significant
Format and Language	9	-2.33	±2.26	0.04	Ho is rejected	Significant
Presentation and Organization	9	-1.33	±2.26	0.22	Ho is accepted	Not Significant
Accuracy and Up-to-datedness	9	-1.46	±2.26	0.22	Ho is accepted	Not Significant
Overall	39	-2.51	±2.22	0.01	Ho is rejected	Significant

Presented at table 2, it shows that the gathered data on the assessment of the two groups of respondents, by physics teachers and physics experts on the level of acceptability of the developed thermodynamics learning packets in terms of content; presentation and organization and accuracy and up-to-datedness reflected the computed t-values was -0.39, -1.33, and -1.46 respectively, which is less than the tabular-t value of ±2.26, this reflects that the null hypothesis is accepted, thus there is no significant difference on the assessment of the two groups of respondents (physics teachers and physics experts) on the level of acceptability of the developed thermodynamics learning packets in terms of content; presentation and organization and accuracy and up-to-datedness.

However, in terms of format and language it was observed that the physics teachers and physics experts significantly differed on their assessment on the level of acceptability in terms of format and language based on the computed t-value of -2.33 which is greater than the tabular-t value of ±2.26, this reflects that the null hypothesis is rejected.

Looking on the overall inference on the level of acceptability of the developed thermodynamics learning packets assessed by two groups of respondents (physics teachers and physics experts) it showed that the computed t-value of -2.51 which is greater than the tabular-t value of ±2.22, this reflects that the null hypothesis is rejected, thus, there is significant difference on the assessment of the two groups of respondents (physics teachers and physics experts) on the level of acceptability of the developed thermodynamics learning packets**.**

Table 3. The Effectiveness of the developed thermodynamics learning packet in improving the thermodynamics achievement based on their pretest and post-test mean scores.

The effectiveness of the developed thermodynamics learning packet was assessed based on the performance of prospective science teachers in the pre-test and post-test given

Scores	Percentage Mean	SD	Level of Achievement	Normalized Score (g)	Level of Improvement
Pretest	80.43	2.2	Satisfactory	0.57	Exemplary
Posttest	91.53	2.1	Outstanding		

Looking at the Table 3, were the learners' academic achievement on nature of heat, gas laws and laws of thermodynamics before and after the utilization of developed learning packet. Considering the data provided on the table, it indicates that before the utilization of learning packet, the prospective science teachers' academic achievement in pretest were 80.43 which was satisfactory achievement, then in post-test were 91.53 which had outstanding achievement. Hence, the prospective science teachers' gain the score of 0.67 which indicates exemplary learning outcomes.

More so, it can be concluded that developed thermodynamics learning packet had a positive effect on the prospective science teachers' academic achievements, as evidenced by the significantly greater mean in the post-test than in the pretest.

It was also supported by Araza, (2023) showed that students who use learning packets tend to perform better in physics exams, as they can apply the concepts, they have learned to solve problems.

Table 4. Test of difference between the pretest and post-test mean scores of the prospective science teachers.

To determine the significant difference in the mean scores of the prospective science teachers, the researcher employed t-test to determine the significant difference between the pretest and post-test mean scores of the prospective science teachers.

In a way, the conduct of the test of inference considered for the level of significance at 0.05, two-tailed with a degree of freedom (df) of 29 and the corresponding tabular t-value was $\pm$2.05.

As gleaned the data, it appeared that the t- value is -23.71 was exceeds in the t- critical value of $\pm$2.05 at the degree of freedom of 29 with p – value of 0.00. The result is significant at $p < 0.05$. Therefore, the null hypothesis is thereby, rejected. Thus, there is significant difference in the prospective science teacher's academic achievement on the nature of heat, gas laws and laws of thermodynamics based on pretest and post-test score as exposed to the developed thermodynamics learning packet.

The claim is also supported with the findings of Rahmasari, and Kuswanto, (2023) found that students who used learning packets in a physics course performed significantly better on exams and quizzes than students who did not use learning packets.

Table 5. Level of Critical Thinking Disposition of Prospective Science Teachers.

As denoted on the table were the summary of the evaluation of the level of critical thinking disposition of

Scores		df	t-test computed value	t-test critical value	P – value	Decision	Interpretation
Pretest	Posttest						
80.43	91.53	29	-23.71	$\pm$2.05	0.00	Ho is rejected	Significant

prospective science teachers in terms of open-mindedness; truth seeking; analyticity; systematicity; self-confidence; inquisitiveness; and cognitive maturity.

Table 5 indicates the critical thinking skills of the prospective science teachers in terms of open- mindedness; truth – seeking; analyticity; systematicity; self – confidence; inquisitiveness and cognitive maturity. The gathered data revealed that prospective science teachers observed as highly critical thinker as gleaned in the computed weighted means of 3.60, 3.55, 3.63, 3.55, 3.25, 3.61, and 3.57 respectively.

The overall computed weighted mean was 3.54 likewise interpreted as highly critical thinker. This study's findings suggest that the thermodynamics learning packets is an effective instructional material for developing the critical thinking deposition.

It was supported to the stands of the following researchers Sari-Dewi and Kuswanto, (2023), Verawati et al, (2024); Samosa and Peria, (2024); Rahayu, and Eliyarti, (2019) that the utilization of learning packets, promote critical thinking dispositions and problem-solving skills in physics and other science courses

These findings suggest that learning packets promotes deeper understanding and higher-order thinking skills among science students.

Table 6. Level of Reflective Thinking of Prospective Science Teachers.

Variables	Weighted Mean	Interpretation
Open-mindedness	3.60	Highly Critical Thinker
Truth seeking	3.55	Highly Critical Thinker
Analyticity	3.63	Highly Critical Thinker
Systematicity	3.55	Highly Critical Thinker
Self-confidence	3.25	Fairly Critical Thinker
Inquisitiveness	3.61	Highly Critical Thinker
Cognitive Maturity	3.57	Highly Critical Thinker
Overall	3.54	Highly Critical Thinker

As gleaned on the table were the summary of the assessment of the level of reflective thinking of prospective science teachers in of self-reflection; mastery; feedback; and realization.

Presented in Table 6 was the level of reflective thinking of prospective science teachers in of self-reflection; mastery; feedback; and realization. The prospective science teachers observed as highly reflective thinker in terms of self-reflection; feedback; and realization as gleaned in the computed weighted means of 3.71, 3.70, and 3.66, respectively. On the other end, prospective science teachers in term of mastery domain were indicated as fairly reflective thinker.

Variables	Weighted Mean	Interpretation
Self-Reflection	3.71	Highly Reflective Thinker
Mastery	2.96	Fairly Reflective Thinker
Feedback	3.70	Highly Reflective Thinker
Realization	3.66	Highly Reflective Thinker
Overall	3.51	Highly Reflective Thinker

The overall computed weighted mean was 3.51 just like interpreted as highly reflective thinker. It was observed that the thermodynamics learning packets is effective instructional material in developing a highly reflective thinker students in understanding the physics concepts and their applications in real-life situations.

These findings were conformed with the studies of Verawati, and Prayogi (2019); Juandi et al, (2024) found that students who used learning packets in a physics course demonstrated higher levels of reflective thinking, problem-solving and metacognitive skills compared to students who used traditional instructional materials.

Table 7. Extent Adaptive Learning Engagement of Prospective Science Teachers.

Looking on the table were the summary of the assessment of the adaptive learning engagement of prospective science teachers in terms of learning goal orientation; task value; self-efficacy; and self-regulation.

Variables	Weighted Mean	Interpretation
Learning goal orientation	3.79	Highly Engaged
Task value	3.76	Highly Engaged
Self-efficacy	3.55	Highly Engaged
Self-regulation	3.43	Highly Engaged
Overall	3.63	Highly Engaged

Variables		R	Adjusted R^2	F - value	P – value	Decision	Interpretation
Learning Achievement	Critical Thinking Disposition	.515[a]	.031	1.134	.379[b]	Ho is accepted	Not Significant
	Reflective Thinking	.472[a]	.098	1.790	.162[b]	Ho is accepted	Not Significant
	Adaptive Learning Engagement	.493[a]	.122	2.009	.124[b]	Ho is accepted	Not Significant

Table 7 revealed the extent adaptive learning engagement of prospective science teachers in terms of learning goal orientation; task value; self-efficacy; and self-regulation. The prospective science teachers observed as Highly Engaged in terms learning goal orientation; task value; self-efficacy; and self-regulation gained in the computed weighted means of 3.79, 3.76, 3.55, and 3.43 respectively.

The overall computed weighted mean yield 3.63 likewise interpreted as Highly Engaged. The thermodynamics learning packets was designed to adjust to a student's strengths, weaknesses, and learning preferences, ensuring prospective science teachers engaged and motivated in learning physics concepts.

It was aligned to the findings of Falode and Gambarı,(2017); Liwanag et al, (2022) that learning packet provide to the students an opportunity to work at their own pace, tend to be more motivated and engaged in the learning process, as they are encouraged to take an active role in their learning.

Table 8. Test of Relationship between Prospective Science Teachers Achievement to the critical thinking disposition, Reflective Thinking and adaptive learning engagement.

Table 8 presents the results of a regression analysis that assessed the relationship between Prospective Science Teachers Achievement to the critical thinking disposition, reflective thinking and adaptive learning engagement.

Looking on the data gathered revealed that critical thinking disposition demonstrates a positive (.515[a]) but not statistically significant relationship, implying that critical thinking disposition has minimal impact on academic achievement of prospective science teachers.

Relatively, the reflective thinking (.472[a]) also shows a positive relationship but is not significant, indicating that the reflective thinking does not significantly impact prospective science teachers' achievement. Meanwhile, the adaptive learning engagement also shows a positive relationship (.493[a]) but is not significant, indicating that the adaptive learning engagement does not significantly affects prospective science teachers' achievement.

As the R-square of the critical thinking disposition, Reflective Thinking and adaptive learning engagement looking 0.031, 0.98, 0.12 indicates that 38.1%, 9*% and 12% respectively of the variance in learning achievement for prospective science teachers suggests a moderate fit. Therefore, the F-values of the abovementioned variables 1.134, 1.790, and 2.009 along with the associated p-value .379[b], .162[b], and .124[b] indicates that factor not collectively influence learning achievement of prospective science teachers. Thus, the researcher accepts the null hypothesis, stating that there was no significant relationship between prospective science teachers' achievement to the critical thinking disposition, reflective thinking and adaptive learning engagement.

It was anchored to findings of Sari, et al (2021), Warsah et al (2021) and Yulianci et al (2021) that markedly low positive relationship was found between critical thinking, reflective thinking and adaptive learning engagement to the academic achievement of the students.

Table 9. Test of Relationship between Prospective Science critical thinking disposition to the Reflective Thinking and adaptive learning engagement.

Table 3 presents the results of a regression analysis that assessed the relationship between prospective science teachers critical thinking disposition to the reflective thinking and adaptive learning engagement.

Presented on the gathered data showed that reflective thinking and adaptive learning engagement show a positive significant relationship. In a more precise analysis, reflective thinking (.827[a]) have a large positive impact on critical thinking disposition, indicating that improving reflective thinking significantly boosts prospective science teachers critical thinking disposition. Likewise, adaptive learning engagement (.807[a]) has a strong positive impact, showing that effective adaptive learning engagement significantly enhances prospective science teachers critical thinking disposition.

The results suggest that factors, such as reflective thinking and adaptive learning engagement, significantly enhance prospective science teachers critical thinking disposition.

Finally, the R-square of the abovementioned variables obtained 0.633 and 0.595, respectively, indicates that prospective science teachers critical thinking disposition account for 63.3% and 59.5% of the variance. It suggests a strong fit. The F-value (48.593) and its corresponding p-value (0.000) suggest that all factors collectively correlate with teachers' critical thinking disposition. Thus, the researcher rejected the hypothesis, stating that there is significant relationship between prospective science teachers critical thinking disposition to the reflective thinking and adaptive learning engagement.

In line with findings of Marnita, et al (2020), that critical thinking disposition was significantly correlated to the students reflective thinking and adaptive learning engagement in learning physics concepts as exposed to innovative instructional materials.

CONCLUSIONS

Based on the findings of the study, the following conclusions were drawn:

1. The evaluators (physics teachers and physics experts) agreed that developed thermodynamics learning packets are excellent in terms of the content, format, presentation, organization, accuracy, and up-to-date information that conforms to need of the Licensure examination for teachers and syllabus.
2. There is significant difference on the assessment of the two groups of respondents (physics teachers and physics experts) on the level of acceptability of the developed thermodynamics learning packets.
3. The developed thermodynamics learning packet had a positive effect on the prospective science teachers' academic achievements, as evidenced by the significantly greater mean in the posttest than in the pretest.
4. There is significant difference in the prospective science teacher's academic achievement on the nature of heat, gas laws and laws of thermodynamics based on pretest and post-test score as exposed to the developed thermodynamics learning packet.
5. The thermodynamics learning packets is an effective instructional material for developing prospective science teachers critical thinking deposition.
6. It was observed that the thermodynamics learning packets was effective instructional material in developing prospective science teachers reflective thinking in understanding the physics concepts and their applications in real-life situations.
7. The thermodynamics learning packets was designed to adjust to a student's strengths, weaknesses, and learning preferences, ensuring prospective science teachers engaged and motivated in learning physics concepts.
8. It showed that critical thinking disposition, reflective thinking and adaptive learning engagement demonstrates a positive but not statistically significant relationship to learning achievement of prospective science teachers. Thus, critical thinking disposition, reflective thinking and adaptive learning engagement has minimal impact on academic achievement of prospective science teachers.
9. It was observed that reflective thinking and adaptive learning engagement, significantly enhance prospective science teachers critical thinking disposition.

Variable		R	Adjusted R^2	F - value	P – value	Decision	Interpretation
Critical Thinking Disposition	Reflective Thinking	.827[a]	.633	13.525	.0.00[b]	Ho is rejected	Significant
	Adaptive Learning Engagement	.807[a]	.595	11.650	.0.00[b]	Ho is rejected	Significant

RECOMMENDATIONS

These recommendations were based on the result of the study conducted by the researcher and suggestions that could improve the study in the future.

1. These recommendations were based on the result of the study conducted by the researcher and suggestions that could improve the study in the future.
2. The developed thermodynamics learning packet may also be used by other satellite campus in in their respective classes to assess potential problems in its utilization and to further validate its effectiveness.
3. Further scrutiny and review may also be done by experts to review the concepts and principles integrated into the developed thermodynamics learning packet.
4. The developed thermodynamics learning packet can serve as a prototype in developing learning materials in other science course.
5. Since the study only involved a smaller population for the pilot-testing, further study involve the student population to further assess the developed thermodynamics learning packet acceptability.
6. Investigating further factors influencing the effectiveness of developed thermodynamics learning packet, including teachers' teaching styles, learning environments, and individual student characteristics.
7. Further research could be conducted to improve students' critical thinking skills and reflective thinking on other topics in Physics. In addition, this study focused on measuring students' critical thinking skills and reflective thinking using open – ended achievement test.
8. Integrating technology and other innovative learning methods into developed thermodynamics learning packet to enhance student digital literacy to enrich their learning experiences.
9. Further review and evaluation of the developed thermodynamics learning packet may be considered to make it more contextualized, localized, and indigenized in the Philippine setting.
10. The use of qualitative approach is also suggested to further determine the developed thermodynamics learning packet acceptability.

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