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Research Article

Improving Thermodynamics Performance using a Multi-Attempt Feedback Mechanism in a Digital Assessment Platform

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ABSTRACT

Introduction: Science education in the Philippines continues to face challenges, particularly in mastering complex subjects like thermodynamics. Traditional assessment methods often fail to foster deep understanding and problem-solving skills. To address this, innovative feedback mechanisms are needed to enhance student learning outcomes in STEM courses.

Objectives: This study aims to determine the effectiveness of a digital multi-attempt feedback system in improving the academic performance, motivation, and conceptual understanding of students enrolled in a Thermodynamics course.

Methods: A convergent parallel mixed-methods design was used. Quantitative data were collected via pretest and posttest scores of 177 students and analyzed using paired t-tests and Hake's factor. Qualitative data from 170 student responses were analyzed thematically to assess perceptions of the feedback system's impact on learning and motivation.

Results: Statistical analysis showed a significant improvement in posttest scores ($p < 0.001$) with medium to high gains (Hake factor: 0.62–0.89). Thematic findings revealed that the feedback system supported three core processes: executing problem-solving procedures, grasping thermodynamic concepts, and visualizing word problems. Students also reported increased engagement, motivation, and ability to connect concepts to real-world applications.

Conclusions: The multi-attempt feedback mechanism significantly improved student performance and learning engagement in Thermodynamics. Its integration into digital assessment platforms offers a promising approach to formative assessment, aligning with SDG 4's goal of quality education through innovative, student-centered strategies.

Keywords: Multi-Attempt Feedback System, Digital Assessment Platform, Thermodynamic Performance, Hakes Factor, Thematic Analysis

INTRODUCTION

The science education in the Philippines lags behind that of many other countries globally, especially at the basic education level. The findings of the Second International Science Study (SISS) and the Third International Mathematics and Science Study (TIMSS) placed the Philippines in a less advantageous position than the other nations that took part in the studies (Philippine Department of Education, Culture, and Sports et al. 2000). The Philippines ranked near the bottom among the seventeen countries that took part in this extensive assessment of educational achievement conducted by the SISS. The findings from the TIMSS assessments conducted in 1995, 1999, and 2003 exhibited notable similarities. This outcome impacts college students who possess a weak foundation in science subjects, potentially influencing their performance at the tertiary level.

According to the findings of the studies by Mc Rollin Vallespin et al. (2019) and Sozbilir et al. (2009), students found advanced concepts in kinetics and thermodynamics to be the most challenging. Many of the principles in thermodynamics must be grasped by both mentors and students, especially since addressing problems in these areas necessitates a high level of mathematical proficiency (Mc Rollyn Vallespin et al., 2019).

Multiple-choice tests are useful when there are large class sizes, a want to test frequently, and a desire to provide graded exams to students as quickly as feasible. However, when it comes to assessing whether or not a student has

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understood the material of a particular course, multiple-choice exams have several disadvantages. The fact that pupils only have one opportunity to reply to each is one of these disadvantages.

Mendoza and Lapinid (2022) found that when students were given three chances to finish online tests with an automated feedback system, their total performance on the tests improved dramatically. This conclusion was supported by the students' thoughtful journal entries, which expressed favorable opinions about the feedback system's use, including helping the students develop their independence as learners, allocate their time effectively among assignments, and comprehend the ideas. All students who decide to enroll in engineering and technology programs must be able to address problems using thermodynamic concepts. To become effective in physics and avoid typical mistakes when tackling thermodynamics problems, students must work on honing their analytical skills throughout their mathematical education. Digambar et al. (2013) state that students struggle greatly to learn physics in general and heat and thermodynamics in particular when conventional teaching methods are employed. According to a different study by Baser (2006), seventh grade students' understanding of heat and temperature ideas is impacted by logical reasoning abilities, the efficacy of conceptual change-oriented training, and traditional scientific instruction. In order to improve the performance of the students in the field, some studies that also focused on thermodynamics used various techniques, such as cooperative learning, concise data processing assessment, and probing (Christensen et al., 2009; Coca, D. M., 2012; Tanahoung et al., 2010). In order to help students in this subject improve and provide feedback, some studies also identify their misconceptions (Engelhardt Beichner R. 2003; Gönen Kocakaya, S. 2010; Harrison et al. 1999; and Kesidou Duit R., 1993).

One of the most crucial elements of the 2030 Agenda for Sustainable Development is education. In addition to being a goal in and of itself (Sustainable Development Goal 4), it is also a target in a number of other SDGs, such as those pertaining to health, employment and economic growth, environmentally conscious production and consumption, and climate change (WorldWideMedia Consulting, 2015). According to their statement, "Ensure equitable quality education and lifelong learning for ALL by 2030" is a requirement for its member institutions.

The foundational theory that the researcher used in this study is the constructivist learning theory, which is based on the idea that learners are active participants in their learning journey and knowlede is constructed based on their experience. The multi-attempt feedback system enables learners to revise on formative clues that supports deeper learning. It also foster better understanding, metacognition and performance in science learning, especially in Thermodynamics course. This is consistent to the study of Nicol & Macfarlane-Dick (2006), where feedback encourages self-regulation that supports deeper learning which is an essential feature of constructivist environments. Another study by Atkinson et al. (2000) conducted a study that perform step-by-step learning through examples and practice that aligns with worked-example effect in constructivism.

OBJECTIVES

The purpose of this study is to determine how an automatic feedback system can assist students perform better on multiple-choice exams in the course of thermodynamics. Students may become more motivated to pursue these subjects and develop their full potential if their performance in the aforementioned course improves.

Studies conducted in various nations have demonstrated that groups receiving quick feedback had much better results than those not receiving comments (Fullmer and Rollings, 1976). Additionally, recent research indicates that feedback systems in multiple-choice assessments greatly enhance students' performance on online tests (Mendoza and Lapinid, 2022; Jang & Marshall, 2018; Merrel et al., 2015). This is the reason we must carry out this study in order to improve our institution's thermodynamics course curriculum and to bring it up to international standards based on UNESCO's Sustainable Development Goal (SDG) 4 by 2030.

The novelty of this research is applying multi-attempt feedback system in digital assessment platform in improving thermodynamics performance in one fo the state universities in the Philippines. Mendoza and Lapinid (2022) focused on the mathematics concepts and did not employ Hake’s factor. While multiple-attempt quizzes have been shown beneficial in other contexts, their effect on Thermodynamics conceptual learning and student motivation in a developing country context remains under-explored, which this study addresses this gap. Hence, to contribute to achieving the goals of UNESCO for 2030 is the reason why the researcher conducted this study. The primary objective of this study is to investigate the effectiveness of a digital assessment platform that integrates a multi-attempt

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feedback mechanism in enhancing student performance in the Thermodynamics course for technology major students at the Technological University of the Philippines. Specifically, this study aims to:

(1) Determine the effect of the multi-attempt feedback mechanism on students' academic performance in multiple-choice assessments in the Thermodynamics course.

(2) Evaluate the influence of the multi-attempt feedback system on students' motivation and learning attitudes toward Thermodynamics.

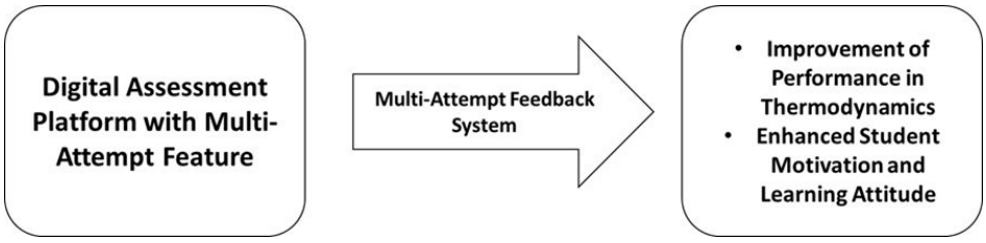

Fig. 1. Conceptual Paradigm

Figure 1 illustrates the conceptual paradigm of this study, which uses digital assessment with multi-attempt feature to evaluate students' comprehension of thermodynamic principles and problem-solving abilities. In order for the students to understand the multi-attempt feedback system regarding their inaccurate answers, they will complete a formative assessment with three repeated responses. The goal of this study is to increase students' academic performance in thermodynamics as well as their motivation and learning attitude for the subject.

METHODS

The purpose of this quasi-experimental method action research study is to ascertain how feedback systems affect multiple-choice exams in a thermodynamics course at one of the Philippines' state universities. A convergent parallel mixed-methods design was employed in collecting the qualitative and quantitative data simultaneously. To enhance validity, triangulation was used by comparing quantitative outcomes (pre- and post-test performance, Hake's gain) with qualitative insights (student perceptions from open-ended survey responses). The convergence of both data sets provided a comprehensive understanding of the impact of the multi-attempt feedback system. Because it is thought to be appropriate for elucidating, interpreting, or contextualizing quantitative findings, a mixed method research design is chosen (Creswell, 2003). The pre- and post-test results and the ratings from the survey questionnaire from students enrolled in thermodynamics courses will provide the quantitative data for this investigation. Conversely, the open-ended responses that students answered from the survey questionnaire to gauge their motivation and attitude about the used approach will yield the qualitative data. Even if the quantitative results are prioritized, the results will be supported by qualitative findings. This study is classified as mixed method research since it uses both quantitative and qualitative data from students enrolled in the Technological University of the Philippines' Thermodynamics course, all of whom are members of the College of Industrial Technology.

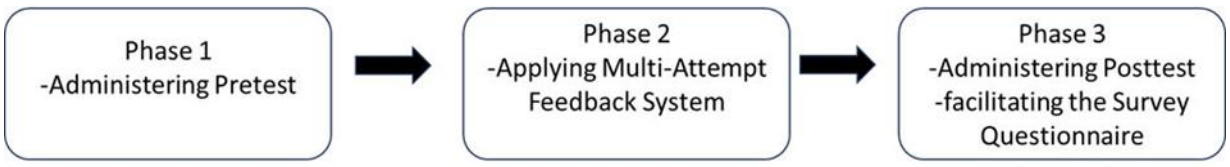

Figure 2. Phases of the study

The phase 1 of the study is administering the pretest in the thermodynamics course. At the beginning of the course, a pretest is administered to gauge their prior knowledge about the course. The next phase is to apply the multi-attempt feedback system as a formative assessment in three topics in thermodynamic course. These three topics are (a) Heat and Temperature, (b) Thermodynamic Pressure and (c) Thermal Processes. This multiple-choice tests are consists of 31 items. The multi-attempt feedback system that was employed in this study is that students were allowed up to three attempts per question; after each incorrect attempt, automated feedback or clues were provided by the system to guide their next answer. At the end of the third topic or the last phase, the researcher administered the

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posttest. After this, there is an exit survey questionnaire that is provided by the researcher. The survey questionnaire is consist of a 5-point Likert scale that include items intended to elicit information about the students' motivation and attitudes toward the feedback system in each of its several sections. This survey questionnaire is validated by three experts in the field. The researcher created the aforementioned questionnaire, which will be verified by professionals to ensure that it is in line with the study's objectives. Before the survey is sent to the students, the required signatures from the institution's management will be obtained. The students had freedom to answer the survey questionnaire or not and this is done voluntarily. The students who participated in the survey questionnaire agreed by the data privacy statement at the end of the survey questionnaire. In addition to being assured of the privacy and confidentiality of their data, the respondents will receive an orientation regarding their part in the study process. All gathered data were kept on an online platform with passcode to maintain the confidentiality of the participants in this study. All the research instruments are encoded in the Google form as the digital assessment platform. This digital platform is chosen by the researcher so that students can easily access the research instruments for their convenience.

The statistical analysis employed by this study is descriptive and inferential statistics. For both the pretest and posttest, the students' mean scores and standard deviations (SD) will be computed. The results from this will use to differentiate the mean scores of pretest and posttest. To ascertain whether the difference between the pretest and posttest scores of students in multiple-choice exams was significant, additional analysis was carried out using a paired t-test. Chao (2017) and Yusop et al. (2015) also employ this statistical method. The following are the study's null hypotheses:

H_0: There is no significant difference in the pretest and posttest of the student score in the multiple-choice testing after the automatic feedback with multiple attempts has been made.

The Hake factor test (normalized gain) was used to more thoroughly assess the results of the pre and post testing. It was employed to evaluate the efficacy of several interventions meant to enhance students' conceptual comprehension of thermodynamics. Necor (2018) used this to determine how well students understood chemistry topics, particularly periodicity of the element. Verbal descriptions and descriptive equivalents for the results of the Hake Factor Test are displayed in Table 1.

Table 1. Descriptive Equivalents for the Hake Faector Test Results

Formula	Scale Range	Verbal Description
$h = \frac{post\ test - pre\ test}{1 - pretest}$	0.71-1.00	High Gain
	0.31-0.70	Medium Gain
	0.10-0.30	Low Gain

The frequency and percentage are used to show the results for the numerical part of the survey questionnaire. The responses of students from open-ended questions that focused on their attitudes and motivations regarding the multi-attempt feedback system are recorded. After transcription, the survey questionnaire transcripts will be coded. Then, using the codes, the themes will be found to support the quantitative data on students' overall perceptions of how the feedback system will aid in their understanding of thermodynamics fundamentals. According to Braun and Clarke (2006), this approach offers a conceptually flexible and easily accessible strategy for analyzing qualitative data. The triangulation of quantitative and qualitative is the basis for crafting a comprehensive framework about the multi-attempt feedback system in order for the educators, administrators and other stakeholders as a diagram to improve the thermodynamics performance of the students.

RESULTS

The presentation and analysis of the results were conducted with a focus on whether multi-attempt feedback system can improve thermodynamic performance in the Thermodynamics course. The results and discussions presented the quantitative and qualitative findings of this study.

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This study's multiple response test consists of 31 multiple-choice items with four options. The pretest of Section C has the lowest mean, while the posttest of Section E has the greatest mean, according to the results in Table 2. According to the standard deviation, the pretest distribution (SD = 9.28) is more dispersed than the posttest distribution (SD = 8.38). A paired t-test was conducted using the pretest/posttest mean scores to ascertain whether it is statistically significant. This result showed that there is a significant difference between the mean scores of pretest and posttest for 177 participants who took the pretest and posttest of the examination (t statistics = 37. 31, t critical = 1.97, $p < 0.05$). This is consistent to the results of Mendoza & Lapinid (2022), Dobson (2008), Johnson & Kiviniemi (2009) that feedback system can have a significant difference in pretest and posttest through the use of multi-attempt feedback system to multiple response testing. Therefore, the null hypothesis must be rejected based on the hypothesis testing, and there is a substantial difference between the students' pretest and posttest scores following the implementation of the feedback system in the course.

Table 2: Statistical Results of Students in Pretest and Posttest in Thermodynamics course (significance at 5% level*)

		Pretest		Posttest			
	n	Mean	SD	Mean	SD	T Stat	*p-value*
Section A	33*	20.93	7.06	39.84	6.56	15.06	<0.001
Section B	36*	20.33	8.99	38.41	8.38	12.83	<0.001
Section C	48*	15.23	4.57	42.22	7.06	23.75	<0.001
Section D	12*	18.5	9.28	46.08	2.64	11.13	<0.001
Section E	48*	19.83	5.43	46.60	3.33	32.09	<0.001

According to table 3 the hake factor test results, sections c, d, and e verbally describe high gain, whereas sections a and b describe medium gain. These demonstrated that every portion benefited from applying the multi-attempt feedback system in thermodynamics over several trials. This result is consistent to voerman et al. (2012) and hill et al. (2015) that feedback system has a significant effect in improving their mean scores in the academic field.

Table 3: Descriptive Equivalents for the Hake Factor Test Results in the pretest/posttest

Section	Mean	Verbal Interpretation
Section A	0.66	Medium Gain
Section B	0.62	Medium Gain
Section C	0.78	High Gain
Section D	0.87	High Gain
Section E	0.89	High Gain

The impact of the multi-attempt feedback system on attitudes and motivation for this course is also significant and should be taken into account as a way to enhance the teaching approach. There are 170 respondents to complete this survey questionnaire so that the researcher could look into why the feedback system was applied to the aforementioned characteristics. They all freely completed the survey and accepted the terms stated at the end of the form. The survey's first question asks whether a feedback mechanism can aid in their understanding of thermodynamics topics. As seen in figure 3, the majority of respondents (n = 119) said that they strongly agreed that feedback systems can aid in their understanding of thermodynamics concepts. According to cavalcanti et al. (2021), their study indicates that in 65.07 percent of their studies, the usage of automatic feedback is linked to an increase in student performance in activities.

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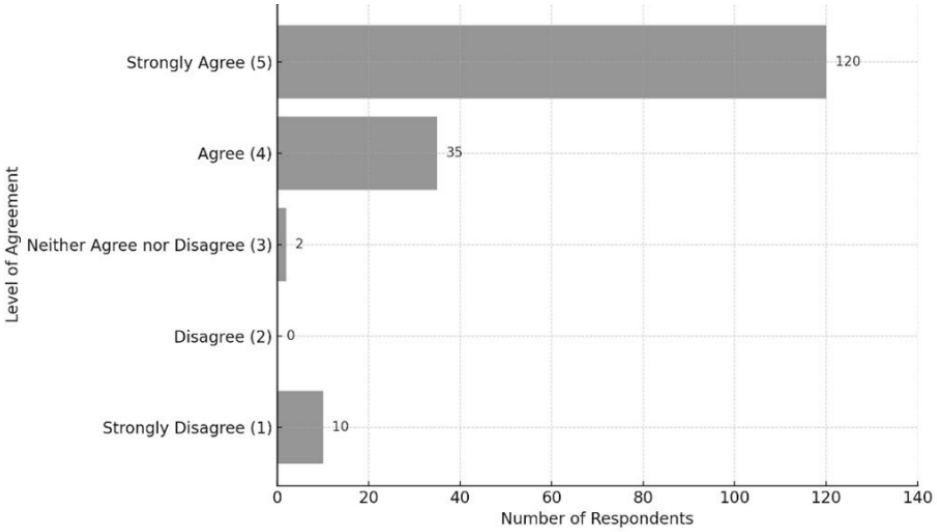

Figure 3: respondents' level of agreement on the multi-attempt feedback system

The primary way in which the feedback system aids students in comprehending the question and providing accurate answers is by applying the correct formula for problem-solving (n = 80) in this course, as illustrated in figure 4. The majority of them concur that receiving comments can aid in understanding ideas that will enable them to address the issue or query at hand (n = 53). The least amount of agreement was that they did not think the feedback system's clues were helpful in solving the presented challenge (n = 3).

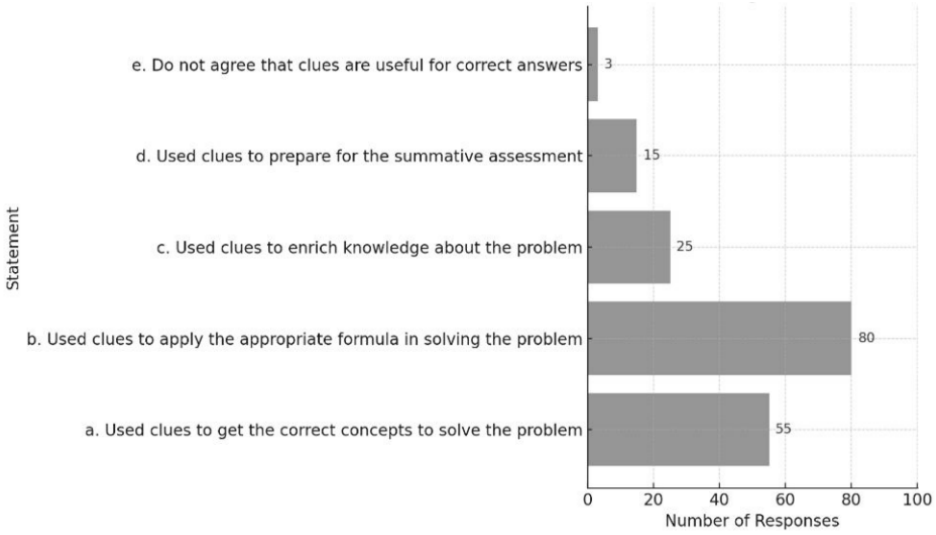

Figure 4: utilization of multi-attempt feedback system in solving problems and assessments

The initial open-ended inquiry in this study seeks their elaboration on their response to the preceding question. The students articulate their reasoning regarding the previous question on how they choose their responses, leading us to identify three overarching themes based on their insights. The three identified themes are (1) grasping the concepts, (2) visualizing the problem, and (3) executing the procedure to solve the problem. The primary themes that emerge from this inquiry indicate that a majority of the participants utilize the feedback as a reference to address the presented issue. The subsequent information includes the codes, their respective frequencies, and a sample response from the participants. This thematic coding indicates that the feedback mechanism can enhance students' grasp of theories, aid in visualizing problems, and facilitate the application of formulas to resolve the issues presented.

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Theme 1: Executing the procedure to solve the problem

The first generated theme is about executing the procedure to solve the problem.

This was the most frequent theme (n = 97), where students reported that the feedback helped them identify and apply the correct formulas and procedural steps. This outcome aligns with the worked-example effect—research showing step-by-step models improve problem-solving skills, especially in fields like physics and engineering (Atkinson et al., 2000). The iterative feedback mimics worked examples by gradually guiding students toward correct actions without giving away solutions upfront. Based on the response of one of the participants states that:

“I strongly agree that the clues are very helpful in answering and solving the given activities. When there are clues given in the activities, I used them as a base on how to solve the problem given.” (Student No. 49)

Furthermore, Gokhan Güner & Erbay (2021) found that middle school students who actively used metacognitive strategies (e.g., planning and monitoring) improved problem-solving outcomes, demonstrating the importance of procedure-focused reflection. This aligns with the findings in Figure 3 wherein most students (n=80) performed better because the multi-attempt feedback system serves as scaffolding encouraged metacognitive monitoring of each step by determining the formula to be used in the problem. The responses of the students are as follows that feedback can be used as a scaffolding to answer the problem:

“With the help of the clues that given I can come up with the correct solution in the problem.” (Student No. 54)

“The clues help me a lot in answering the activity because sometimes I don't know what to do on the problems but when I see the clues I know what will I going to do, The clues serves as my guide to answer the problems” (Student No. 75)

This procedural improvement is also consistent with studies linking automated solution feedback to enhanced algorithmic thinking and self-correction. For example, Mejeh et al. (2024) reported that adaptive feedback systems significantly improved students' accuracy in digital assessments.

Theme 2: Grasping the Concepts

The second most cited theme (n = 46) indicated that feedback enhanced conceptual clarity. This is consistent to the study of Brundage and Singh’s (2023) research, which emphasizes conceptual multiple-choice testing in Thermodynamics to identify core misunderstandings and reinforce understanding. Additionally, formative feedback is strongly tied to metacognitive awareness. A study by Nicol and Macfarlane-Dick (2006) demonstrates that reflective feedback triggers self-regulation and deeper conceptual processing . This can be triangulated by the quantitative findings in Table 3, wherein the Hake Factor Test results a high gain in the posttest. Students not only improved scores but also conceptual mastery, which the following students have the following responses:

“For me, it's important to use a clues to get the correct concepts to solve the problem. Therefore, students can understand well the theory.” (Student No. 25)

“When giving clues, I remember the concepts because the concept is the main foundation of every problem. With

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that, it is easy for me to remember the formula and apply it in solving the problem." (Student No. 36)

Theme 3: Visualizing the Problem

Though less common (n = 2), visualization appeared essential for some learners. Effective problem visualization has been shown to reduce cognitive load and aid comprehension of abstract concepts (Mayer, 2009). Since there are items that are word problems involving thermodynamic topics, the result of the paired t-test shows a significant increase in the pretest and posttest scores in Table 2. This table shows that all sections have a significant improvement of scores from pretest to postest. Some students have responses that visualization of the problem helps them answer the word problem effectively. The following responses are:

"It helps me to visualize the formula and the process must be used to solve the problem." (Student No. 84)

"I used the clues for helping me for visualize the problem if I don't know how to start in beginning." (Student No. 8)

The multi-attempt feedback system utilized in this study was evaluated by the respondents. Forty-nine percent (n = 83) of the respondents evaluated the feedback system as excellent, as illustrated in Figure 5. Therefore, from their viewpoint, the feedback provided in this study genuinely aids them in grasping the concepts and enhancing their analytical abilities.

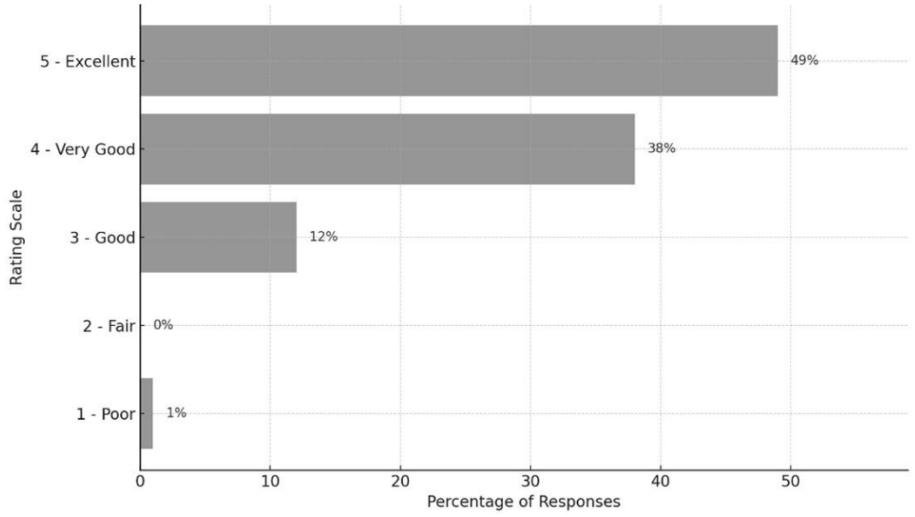

Figure 5: Student's Rating on the Multi-Attempt Feedback System

The second open-ended question explores how a multi-attempt feedback system can enhance their learning experience in the course, leading us to identify three key themes from their responses. The themes are (1) applying course concepts to industry, (2) to enhance knowledge and understanding of Thermodynamics, and (3) to address areas of weakness in the course material.

Theme 4: Applying Course Concepts to Industry

Students reported that the feedback system enabled them to better connect thermodynamics theory with real-world industry applications. This aligns with findings in engineering education, where contextual relevance enhances engagement and comprehension. For example, Baran and Sozbilir (2017) implemented a Problem-Based Learning (PBL) approach in thermodynamics, demonstrating that students developed stronger application skills and

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argumentation abilities when course content directly related to real-life engineering scenarios—this mirrors your students' reported experiences. This is the reason wherein one of the students responded as:

"Because we can apply my learning to industry." (Student No. 2)

Theme 5: Enhanced Knowledge and Understanding of Thermodynamics

Nearly half of the respondents (n = 83; 49%) rated the feedback system as "excellent," affirming its strong impact on conceptual understanding and analytical ability. This result is consistent with evidence from feedback research. Nicol and Macfarlane-Dick (2006) emphasized that well-structured formative feedback fosters self-regulated learning and deepens comprehension. This result can triangulated with the high gain of scores in the posttest (Table 4) and an excellent rating in employing multi-attempt feedback system. Additionally, Mejeh et al. (2024) showed in a mixed-methods study that adaptive feedback significantly improved not just test scores but students' self-regulated learning behaviors. One of the reponse of students related to this theme is:

"it is important for the student to have a feedback system for the responses and know the learning course for the students"

-Student No. 98

Theme 6: Addressing Areas of Weakness

Students noted that the feedback system helped them identify and strengthen weak areas in their knowledge. This is aligned with research on the "testing effect" where repeated retrieval and immediate feedback expose gaps and reinforce learning. Carpenter et al. (2018) found that retrieval practice with feedback significantly enhances conceptual mastery, especially in science learning. In addition, Derks and Bakker (2013) introduced the idea of "desirable difficulties": intentionally challenging learning tasks with corrective feedback promote deeper processing and durable learning gains. The multi-attempt feedback system exemplifies this principle by prompting students to attempt, reflect, and correct their misconceptions. The student responded this that:

"Feedback is one of the most effective teaching and learning strategies and has an immediate impact on learning progress to us as a student." (Student No. 97)

The respondents were inquired about the necessity of enhancing the feedback system utilized in their course. According to Figure 6, a significant number of students express satisfaction with the multi-attempt feedback system utilized in this course (n = 86). It is essential to gather the suggestions and comments from fellow students to enhance the feedback system in this study (n = 84). The subsequent examples represent the responses provided by students regarding their comments and suggestions within the feedback system utilized in this study:

"The feedback system in this course is good, but I think there are improvements that can be done and to be polished so that it can be more enjoyable, yet effective."(Student No. 28)

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"It should add a question to determine the level of difficulty of a subject that should be answered by the students by knowing their capabilities or weaknesses when it comes to this matter." (Student No. 86)

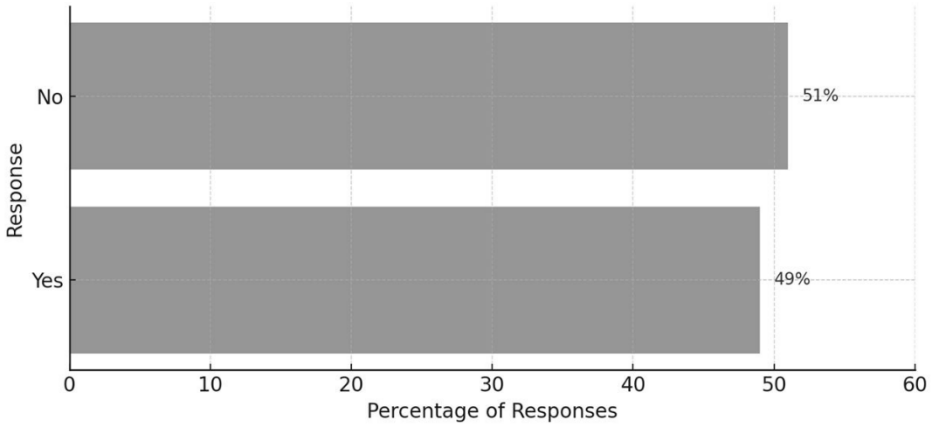

Figure 6: Percentage of Respondents that need enrichment of the multi-attempt feedback system.

This study inquired about the number of repeated responses students recommend for answering formative assessments in order to receive feedback on their incorrect answers. According to the figure 7, a majority indicate that there should be two repeated responses (n = 94) to enhance their understanding and learning in the specified course. The students do not concur that an increased frequency of responses during formative assessment will enhance their understanding of concepts and their ability to independently solve problems (n = 21). Future studies by certain researchers will explore these findings further.

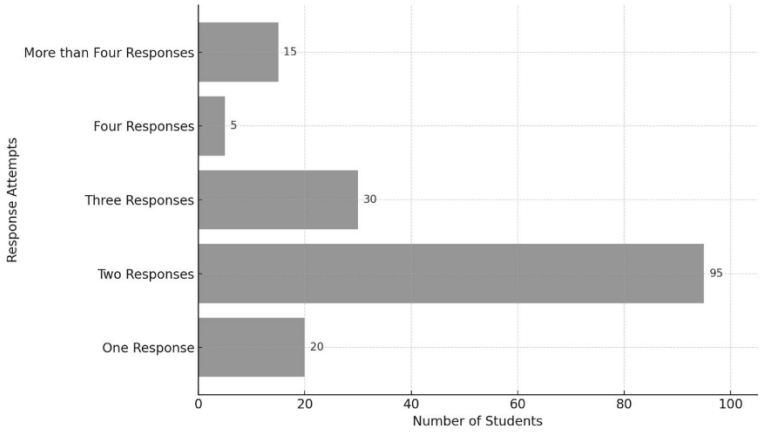

Figure 7: Suggestion of Students for Number of Attempts in Formative Assessment

DISCUSSION

The impact of a multi-attempt feedback system in digital assessment platform on multiple response testing significantly influences student performance in the Thermodynamics course, enhancing learning through multiple attempts in formative assessment. This finding aligns with the results of Mendoza and Lapinid (2022), Dobson (2008), and Johnson and Kiviniemi (2009), suggesting that employing feedback systems and allowing repeated attempts at multiple answer testing can lead to notable differences in pre-test and post-test scores. Therefore, in light of the findings from the hypothesis testing, it is necessary to reject the null hypothesis, indicating a significant

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difference between the pre-test and post-test scores of students following the implementation of the feedback system in the curriculum. This is demonstrated by Hake's Factor, which indicates a significant increase in scores from the pretest to the posttest of the course, with an overall average gain of 0.76. This study supports the findings of Voerman et al. (2012) and Hill et al. (2015), which indicated that implementing a feedback system significantly influenced students' capacity to enhance their average scores in academics.

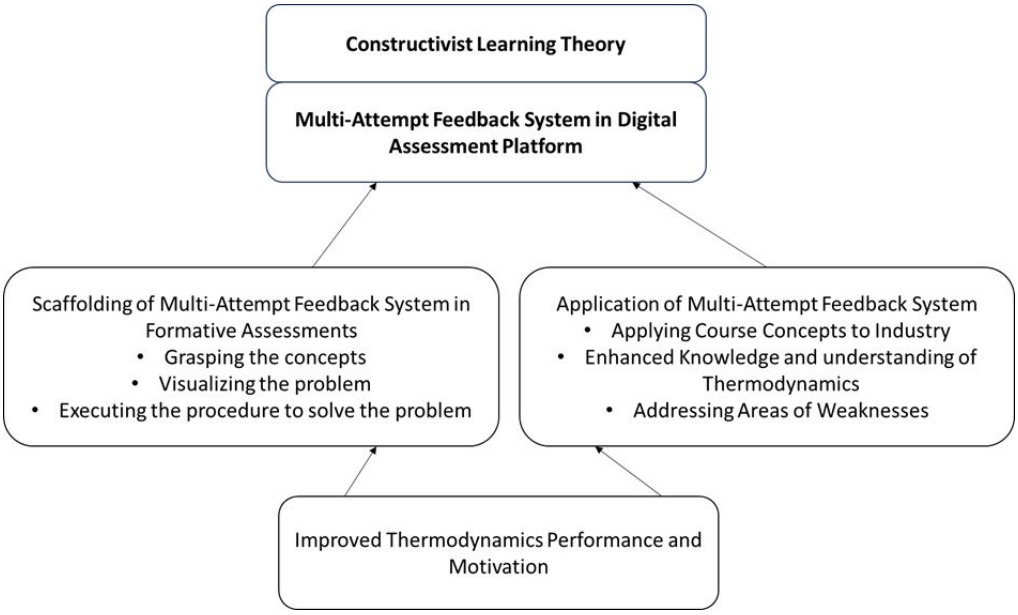

Figure 8: Theoretical Framework by Applying Multi-Attempt Feedback System in Digital Assesment Platform

The findings from the quantitative results in this study suggest that implementing a multi-attempt feedback system with repeated attempts in digital assessment platform could be an effective approach to help them execute the procedure to solve the problem, grasping the concepts and visualizing the problem. A variety of feedback initiatives could provide students with a more iterative and interactive learning experience. This enables individuals to assess their understanding in a relaxed environment, potentially enhancing self-assurance and revealing aspects that need further focus. Instead of just being told the right answer, students have the opportunity to gain insights from their errors through feedback on their efforts. A multi-attempt feedback system in digital assessment platform can prove to be beneficial in a Thermodynamics course, given its complexity and rigor. It is essential for students to grasp abstract concepts and utilize them in practical scenarios related to thermodynamics, which can prove difficult without a strong base of knowledge and effective problem-solving abilities. By dissecting problems into smaller, manageable parts and offering feedback on each attempt, students can enhance their grasp of the concepts and visualize challenges in a more intuitive manner. This can help in recognizing patterns and connections among different ideas, potentially enhancing problem-solving skills. Additionally, by practicing the technique for addressing the issue, learners can strengthen their understanding and abilities. This is particularly beneficial when addressing more complex issues that require a more profound understanding of the underlying concepts. The learning experience of students to be more confident in answering the questions can be extended by applying course concepts to industry, enhanced knowledge and understanding of thermodynamics and addressing areas of weakness in their course material. The proposed theoretical framework for utilizing a multi-attempt feedback system in a Thermodynamics course presents a promising approach to enhancing conceptual understanding, visualizing problems, and applying solutions. This theoretical frameowrk is derived from the constructivist learning theory as the foundational lens for building the multi-attempt feedback system. The application of the multi-attenpt feedback system that thermidynamics concepts can enhance learning and konowledge, apply the concepts into industry, and addressing areas of weaknesses in terms of intended learning outcomes of the course. Based on the quantitative and qualitative findings that multi-attempt feedback system can help imrove the thermodynamics performance and motivation of

the students. This approach can assist students in developing the necessary information and skills for success in the course and future endeavors by offering a more iterative and participatory learning experience.

It is suggested that administrators, educators, technical experts can integrate multi-attempt feedback system in planning and creating digital assessment platform for their formative assessment. Other researchers can replicate this study in different domains like Chemistry, Biology or other Science education. For future studies, other researchers can also conduct their study in Basic education or other research locale.

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