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DESIGN THINKING APPROACH AND STUDENTS' PROFICIENCY IN ENERGY IN MOTION

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Abstract

Applying the Design Thinking Approach (DTA) to address its lack of conceptual clarity in instruction is crucial since it may improve students' scientific literacy. DTA was integrated into teaching physics lessons and testing its effect on students' proficiency to address this issue. The research method employed was quantitative, applying a quasi-experimental design. The sample comprised two (2) sections in Grade 7 of 41 students, each with comparable mean percentage scores (MPS) and statistically insignificant. The data collection technique utilized pretest and posttest. Then, the data were analyzed descriptively and statistically using a *t*-test. The findings revealed that the experimental and control groups had fair pretest scores. The experimental group garnered excellent proficiency in the post-test, while the control group had a high average. It affirmed the effectiveness of DTA. Statistical results also showed a significant difference between the pretest and posttest scores. The DTA, known for developing critical thinking, creative confidence, problem-solving, innovation, and other 21st-century skills, can affect a positive innovation in physics teaching, support curriculum, and pedagogical updates, and consequently help improve students' proficiency in physics.

Keywords: Design Thinking Approach, Proficiency, Physics Teaching, Quasi-Experimental Research, 21st Century Skills.

Introduction

Educational internationalism challenges every thriving country's academic curricular policy to adopt best practices adhering to standardized measures and trends of influence set by the Organization for Economic Cooperation and Development (OECD) and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) (Forsberg, 2019). This is why K-12 is designed for students to conform to global educational competence, where the essential contents of the science curriculum applying effective 21st-century approaches are needed. Implementing the K-12 in the basic education curriculum is the key to quality education and the country's growth (Abueva, 2019).

According to Cayless and Jordan (2024), physics is considered one of the most difficult subjects because it accompanies sophisticated problem-solving and mathematics, resulting in the least learned competencies in science. However, teachers find ways to plan and apply new approaches to facilitate student learning (Almadrones & Tadifa, 2024).

Based on the result of the National Achievement Test (NAT) 2015 analysis done by Ceblano (2019), despite ongoing programs on improving teaching strategies among teachers, the levels of performance in science of the students in NAT pooled from 18 public secondary schools obtained the MPS of 33.94 (low mastery) signifying that science needs more attention. Similarly, analyses of performances in the Programme for International Student Assessment (PISA) 2018 of selected students of fifteen years of age from public secondary high schools from all regions in the Philippines revealed that Filipino students reached an average score of 357 points in scientific literacy, significantly lower than the OECD 489 points. Keeping the country's overall rank at sixth or last out of 6 participating ASEAN countries is alarming (OECD, 2019).

Most recently, the Philippines again garnered uncomfortable truth in PISA 2022, where the country landed in the bottom 10 out of 81 countries. The Philippines scored 373 out of 485 in scientific literacy, which made Filipino students attain level 6.

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For every 20 points lacking from the average, it is a year's pace of learning for 15-year-old Filipino students (Acido & Caballes, 2024). The results show the criticality of advancing the quality of basic education in the Philippines.

Several attempts were made to address successful students' problem-solving and proficiency. One is an "out of the box" thinking five-phase model called the Design Thinking Approach (DTA). Callahan (2019) also observed that DTA is integrated into K-16 curricula to nurture the development of 21st-century skills. The study conducted by Camacho (2018) described DTA as system-oriented, human-centered, and creation-based. It is applied in curriculum design, teaching-learning approach, and teacher training, indicating its specific advantage aligned with educational goals, like teaching and learning.

According to Latteman et al. (2020), studies on the application and effectiveness of the DTA were mostly tested in business and innovation themes. However, while it is still growing in teaching and learning in regular classrooms, researchers recommended continuous and additional studies to determine learning outcomes in teaching and educational settings and to modify the nonlinear and iterative EDIPT stages to address its lack of conceptual clarity (Camacho, 2018).

This study introduced the DTA in teaching physics using topics from Unit 3: Energy in Motion, such as motion, wave, sound, light, heat, and electricity, to Grade 7 students of Tampakan National High School to investigate its effects on their proficiency in learning physics lessons by comparing the pretest and posttest scores.

Statement of the Problem

This study determined the effectiveness of DTA as a teaching strategy for the Grade 7 students' proficiency in Physics at Tampakan National High School. It answered the following questions:

1. What is the proficiency level of the experimental and control groups in the average scores in the pretest and the posttest?
2. Is there a significant difference between the scores in the:
   2.1. pretest of the experimental and control groups;
   2.2. posttest of the experimental and control groups;
   2.3. pretest and posttest of the experimental group; and
   2.4. pretest and posttest of the control group?

In the Philippines, a study by Pacturan et al. (2024) found a positive correlation between the integration of gamified techniques and students' academic performance, highlighting both the benefits and challenges educators face in implementing these strategies. In Esperanza National High School, research by Taladtad (2023) highlighted that students' passive learning behaviors challenge teachers seeking to engage and motivate them. Taladtad suggested that teachers should implement adaptable learning strategies to capture the interest of passive and unmotivated learners. Therefore, teachers relentlessly seek ways to motivate and engage their learners. A lack of enthusiasm, engagement, and progress in learning characterizes a classroom of unmotivated learners.

Research has been done on the influence of gamification on student motivation and performance when learning English as a foreign language in higher education, how gamification can improve EFL students' writing abilities, and how gamification can help students learn the language through mobile devices: high school students' perception, gamification in education: a case study of using gamification approach in the acquisition of English verb tenses, and gamification approach in language (Baytekin & Avara, 2023; Huseinović, 2024; Liepa, Semeneca, & Olehnovica, 2021; Llabrés Estelrich, 2022; and Pingmuang, & Koraneekij, 2022; Gabio & Protacio, 2025).

However, limited studies have been conducted locally using gamification-based techniques to increase students' motivation in high school. Moreover, no experimental undertakings that account for its effectiveness among grade 8 students have yet been explored in Esperanza National High School.

Hence, this study was conducted to identify the level of acceptability of gamification-based technique in terms of components, dynamics, and mechanics; the level of motivation of learners between the control and experimental groups; the significant difference in the motivation of learners between control and experimental groups; and the significant relationship between the acceptability of the gamification-based technique and the motivation of learners.

Methodology

The data and information were treated and analyzed using the quantitative quasi-experimental research method and statistical tools such as mean, mean percentage score (MPS), standard deviation (SD), and *t*-test (Mahat et al., 2024). Two Grade 7 sections of Tampakan National High School were observed as experimental and control groups. A pretest was given to assess prior knowledge. After the teaching approaches were applied, a posttest was administered to measure the students' proficiency in physics lessons (Johnson & Christensen, 2024; Gabio & Protacio, 2025). The data treatment involved teaching the experimental group using the iterative EDIPT stages of the DTA and the control group using the conventional approach (Dam, 2024; Calyawa & Tampus, 2023).

The study was conducted at Tampakan National High School, Dao Street, Poblacion, Tampakan, South Cotabato, Philippines. The study's respondents were two Grade 7 sections under the K-12 Basic Education Curriculum (BEC), School Year 2024-2025. The first section, with 41 students, was under the experimental group, while the second of 41 students was under the control group (Mahat et al., 2024). Parents, class advisers, and student orientation were conducted together with the signing of the consent forms.

The data-gathering instrument in this study includes the pretest and posttest assessments (Protacio, 2021). The 4As lesson exemplars were employed in teaching the control group, and the lesson exemplars with the EDIPT stages of DTA were employed in teaching the experimental group.

The researcher-developed multiple-choice quarterly assessment used for pretest and posttest assessments (Johnson & Christensen, 2024) comprised the 3rd quarter physics lessons of Unit 3: Energy in Motion, such as motion, wave, sound, light, heat, and electricity. The items have undergone Quality Assurance (QA) through:

Patterned from Yusoff (2019), the test items aligned with the Table of Specification (TOS) and lesson exemplars were validated using the Test Questionnaire Validation Tool on a scale of 1 to 4. The test items were evaluated by five (5) selected physics and science teachers composed of one (1) doctoral and four (4) master graduates. Following through the computations of the Content Validity Index (CVI) recommended by Polit & Beck (2006), the result in the scaled content validity index (S-CVI) of the Pretest/Posttest was 1.00, while all computed I-CVIs were above the threshold value. Hence, the instrument was valid.

A 40-item researcher-made test was administered to Grade 8 students in Tampakan National High School. The scores underwent item analysis for internal reliability consistency using the determinant tool of the Kuder-Richardson Formula 21 (KR-21). After the test was administered for pilot testing, it attained a value of 0.78, which is interpreted as “acceptable” (Uyanah & Nsikhe, 2023). Hence, the researcher-made test was reliable.

The researcher adopted the nonlinear and iterative EDIPT stages of the DTA described by Dam (2024) in teaching physics lessons to the experimental group, while the modified 4As (Activity, Analysis, Abstraction, Application) format was utilized for the control group. The lesson exemplars were set in eight weeks of three Learning Activity Sheets (LAS) containing the physics topics. The Most Essential Learning Competencies (MELCs), developed and implemented by DepEd as described in DepEd Order No. 8, s. 2015 and DepEd Order No. 21, s. 2019, studied and used by Reyes and Caballes (2020) and Zalun (2023) were used in this study. A round of nonlinear and iterative EDIPT stages of the DTA includes three or more related lessons provided in the LAS. DepEd Order No. 31, Series of 2012, established a 4-hour non-negotiable weekly teaching period during which the required lessons and assessments based on MELCs were delivered. Hence, the fourth day of the teaching schedule was entirely devoted to performance tasks using the conventional approach and DTA.

Patterned from the process of Raguindin (2007), the researcher secured approved communication letters. A request for permission from the school’s division superintendent of South Cotabato and the principal of Tampakan National High School was furnished. This followed the validity and reliability screening of the research instruments that composed the 40-item researcher-made test and the physics lesson exemplars by five (5) content experts. The test items were administered to students, and the internal consistency reliability was determined using the KR-21. The researcher also followed processes for the selection and identification of the sample. The experimental and control groups were chosen purposively and assigned through the toss-coin method. The teaching experiment started by administering the pretest and ended with the posttest. The experiment was accomplished within the third grading period of 8 weeks from validating research instruments, teaching and testing the Conventional and Design Thinking Approaches, and gathering and interpreting data.

The following shows the standard for determining the proficiency in pretest and posttest scores based on DepEd Order No. 8, Series of 2015.

Levels of Proficiency in the Pretest and Posttest

Mean Percentage Score (%)	Proficiency Interpretation
90 - 100	Excellent
85 - 89	Above Average
80 - 84	Average
75 - 79	Below Average
Below 75	Fair

The pretest and posttest results of the experimental and control groups were treated. The raw scores were expressed in the transmuted values, from which the MPS was determined based on DepEd

Memo No.42, Series 2020. This was done to establish whether the levels of students' proficiency under the DTA and conventional approach have significant differences using the *t*-test analysis.

After gathering, organizing, and tabulating all necessary data on the pretest and posttest scores, appropriate statistical treatment in SPSS was used for analysis and interpretation. The mean percentage score (MPS) and standard deviation (SD) were used to compare the scores gained by the experimental and control groups. A two-tailed *t*-test determined the significant differences between the scores. The scores in the pretest and posttest attained by each type of group were compared using a paired sample *t*-test, while scores in the pretest and posttest between the two groups were compared using an unpaired sample *t*-test (Kim, 2015; Mahat, Neupane, & Shrestha, 2024).

Results and Discussion

Proficiency Levels of the Experimental and Control Groups Regarding the Pretest and Posttest Average Scores

The following tables present the determined proficiency levels of the experimental and control groups in terms of the average pretest and posttest scores. The raw data were treated and interpreted using DepEd Order No. 8, series of 2015, and DepEd Memo No. 42, series of 2020.

Table 1: Proficiency Levels of the Experimental and Control Groups in the Pretest Average Scores

Group	N	MPS	SD	Qualitative Description
Experimental	41	69	3.55	Fair
Control	41	68	2.90	Fair

Table 1 shows the proficiency of Grade 7 students in the pretest. The data revealed that the pretest scores of the experimental group had an MPS of 69% and an SD of 3.55, while the pretest scores of the control group had an MPS of 68% and an SD of 2.90. Both experimental and control groups' MPS were below 75%, which is interpreted as "fair."

Based on DepEd Order no. 8, series of 2015, and DepEd Memo no. 42, series of 2020, this likely confirms the result of the respondent sampling where the two groups' second quarter grades in science were compared using an unpaired sample t-test, which determined the difference in their transmuted grades as not statistically significant. Similarly, the pretest results for the two groups have shown that the respondents have comparable academic capabilities regarding their base and prior knowledge of the coverage of Energy in Motion. This confirms the findings of Afni & Rokhimawan (2018) that students may have low pretest scores before the lessons can be introduced and may also have low scientific literacy.

Table 2: Proficiency Levels of the Experimental and Control Groups in the Posttest Average Scores

Group	N	MPS	SD	Qualitative Description
Experimental	41	92	6.18	Excellent
Control	41	89	6.84	Above Average

Table 2 shows the proficiency of Grade 7 students in the post-test. Data revealed that the posttest scores of the experimental group had an MPS of 92% and an SD of 6.18, which is higher than the posttest scores of the control group, which had an MPS of 89% and an SD of 6.84. Consequently, the experimental group's MPS attained within 90 - 100% was interpreted as "excellent," while the control group's MPS attained within 85 - 89% was interpreted as "above average."

The constructive effect of design thinking raised the students' post-test scores higher than those of the control group, which used the conventional approach (Simeon et al., 2022). Furthermore, according to Fatkhurrohman (2024), the students' learning with design thinking was deepened to mastery by developing creative confidence, innovation, and critical thinking gained from the EDIPT stages (Dam, 2024).

t-test Analysis on the Difference Between the Experimental and Control Groups in the Pretest and Posttest Scores

After determining the proficiency levels of the experimental and control groups, a two-tailed, unpaired sample *t*-test was used to determine the statistical difference between the two groups regarding the pretest and posttest scores. The next two tables discuss and show these differences.

Table 3: Comparison Between the Experimental and Control Groups in the Pretest Scores

Group	N	MPS	SD	df	*t*-stat	*t*-crit	Qualitative Description
Experimental	41	69	3.55	77	1.70	1.99	Not Significant
Control	41	68	2.90				

α = 0.05 *Level of Significance*

Table 3 presents the *t*-test analysis in the pretest average scores of the experimental and control groups. The MPS and SD of the experimental and control groups are 69% and, 3.55, and 68% and 2.90, respectively, making the experimental group higher than the control group. However, the data table revealed that the *t*-stat of 1.70 is less than the *t*-crit of 1.99. This statistical data suggests that the alternative hypothesis can be rejected. Hence, the observed difference between the pretest scores of the experimental and control groups is not statistically significant. There is sufficient evidence to suggest that the groups were similar regarding the pretest.

Without applying any teaching approach, neither design thinking nor conventional, Patel et al. (2024) observed that the pretest scores of the experimental and control groups may be comparable or relatively low. According to Thorndike's Law of Readiness, students taking a test with little or no prior knowledge are likely not ready.

Table 4: Comparison Between the Experimental and Control Groups in the Posttest Scores

Group	N	MPS	SD	df	*t*-stat	*t*-crit	Qualitative Description
Experimental	41	92	6.18	79	2.54	1.99	Significant
Control	41	89	6.84				

α = 0.05 *Level of Significance*

Table 4 shows the *t*-test analysis of the experimental and control groups' post-test scores. The experimental and control groups' MPS and SD are 92% and 6.18 and 89% and 6.84, respectively, making the experimental group's post-test scores higher than the control group’s. The data table also shows that the *t*-stat of 1.70 is less than the *t*-crit of 1.99. This means failing to reject the alternative hypothesis that there is a significant difference between the scores in the experimental and control groups' post-tests.

As confirmed by the study by Jiang and Pang (2023), the experimental group was superior to the control group regarding the posttest. As applied to teaching, the researchers further indicated that DTA improved students’ academic achievement by enhancing their creative confidence. Moreover, To and Liu (2021) observed that the experimental group possessed more improved creativity than the control group.

t-test Analysis on the Difference Between the Pretest and Posttest Scores of the Experimental and Control Groups

The following tables show the statistical difference between respondents' pretest and posttest scores. The researcher used a two-tailed paired sample t-test to compare the data.

Table 5: Comparison Between the Pretest and Posttest Scores of the Experimental Group

Score	MPS	SD	N	df	*t*-stat	*t*-crit	Qualitative Description
Pretest	69	3.55	41	40	-26.81	2.021	Significant
Posttest	92	6.18					

α = 0.05 *Level of Significance*

The *t*-test analysis in the pretest and posttest average scores of the experimental group is presented in Table 5. The MPS and SD in the pretest and posttest scores of the experimental group are 69% and 3.55, and 92% and 6.18, indicating that the posttest scores are higher than the pretest scores. The data table also shows that the *t*-stat of -26.81 is less than the *t*-crit of 2.021. This means failing to reject the alternative hypothesis that there is a significant difference between the scores in the pretest and posttest of the experimental group.

This finding is supported by the study by Simeon et al. (2022), which found that all students in the experimental group, regardless of gender, garnered higher and improved achievement scores. Students could relate to specific physics lessons by using the design thinking processes and developing creative and innovative ways to deepen their understanding and mastery of the lesson.

Table 6. Comparison Between the Pretest and Posttest Scores of the Control Group

Score	MPS	SD	N	df	*t*-stat	*t*-crit	Qualitative Description
Pretest	68	2.90	41	40	-17.58	2.021	Significant
Posttest	89	6.84					

α = 0.05 *Level of Significance*

Table 6 presents the t-test analysis in the pretest and posttest scores of the control group. The MPS and SD in the pretest and posttest scores of the control group are 68% and 2.90, and 89% and 6.84, indicating that the posttest scores are higher than the pretest scores. The data table also shows that the *t*-stat of -17.58 is less than the *t*-crit of 2.021. This means failing to reject the alternative hypothesis that there is a significant difference between the scores in the pretest and posttest of the control group.

Similar to the results discussed by Simeon et al. (2022) and Sunarti et al. (2024), the posttest scores of the control group were generally higher and significantly different from the pretest scores for control groups where the conventional approach was applied. Safriana et al. (2024) admitted that the lack of differentiated and creative instruction, teacher readiness, and technology-based approaches, among other things, is prevalent in practice and can be improved.

Conclusion

Design Thinking Approach significantly enhances students' proficiency in Energy in Motion. The experimental and control groups exhibited similar fair levels of understanding in the pretest. After implementing DTA, the experimental group showed a remarkable improvement, achieving an excellent rating in the posttest, whereas the control group did not exhibit similar gains. The DTA is an effective instructional strategy for improving students' understanding and application of complex concepts in Energy in Motion.

The pretest scores of the experimental and control groups show no significant difference, indicating homogeneity in prior knowledge and skills. However, the posttest results revealed a significant difference, with experimental group outperforming the control group. This indicates that the DTA significantly positively affected students' understanding and application of Energy in Motion concepts, making it an effective instructional strategy.

The experimental group showed significant improvement in posttest scores compared to pretest scores, demonstrating the effectiveness of DTA. The control group also shows significant improvement, indicating that conventional instruction can enhance students' understanding. However, the experimental group's superior post-test performance indicates that the DTA is particularly effective in promoting a deeper understanding and application of Energy in Motion concepts.

Conflict of Interest

There is no conflict of interest by the authors in this manuscript.

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