From Concept to Classroom: Designing and Implementing the Bingolectrik Game to Enhance Conceptual Understanding of Electrical Energy

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ABSTRACT

The study emphasizes the importance of game-based in learning and teaching, this to address the difficulties of learners in their conceptual understanding in topics in physics, particularly in power generation, transmission and distribution. The insufficient of local learning materials in Physiscs education makes it more difficult for a learning to thrive, through development of Bingolectrik Card Game which align in K-12 Curriculum, this could help address conceptual understanding. The study aimed to (1) identify the least mastered competency among students and teachers in Grade 9 Physics topics. (2) develop and validate a Bingolectrik Card Game, and (3) Identify learners' achievement through scores in learning activity, pre-test and posttest. The study utilized Research and Development (R&D) Model and supported with ADDIE Model. The result for needs assessment shows that power generation, transmission and distribution among the barely mastered topics for learners (M=2.46) and partially mastered topic for teacher (M=3.33). The developed Bingo Card, Game Mechanics and Question Roulette obtained "Outstanding" in terms of goals and objective, and Card Design (M=4.60), and Components and Organization (M=4.64), while "Very Satisfactory" for playability and playfulness, and usefulness (4.45) with a full compliance for language validation. Learners score in the learning activity mostly fall on Satisfactory level (56%). The learners also achieved significant gained in their pre-test and posttest (M=7.14 to M= 13.13) with a normalize gained of (M=0.68) indicating an average gained and to reject null hypothesis. The result of the studies highlights that the used of Bingolectrik in teaching and learning would have significant progress of student conceptual understanding and academic performance.

Keywords: Physics Education, Conceptual Understanding, K-12 Curriculum, Card Game, Power Generation, Transmission and Distribution

INTRODUCTION

Science education is important in building knowledge, skills and critical thinking of learners. The UNESCO Incheon Declaration and SDG 4 emphasize the need for inclusive, equal opportunity and quality education, while SDG 9 calls for creative and technology-driven teaching. SDG's goal 17 emphasizes the importance of strong partnership for the promotion of science and technology projects including the role of DepEd (UNESCO, 2015). Physics was often identified as difficult by students due to its difficult nature, abstract ideas and the strong problem-solving skills needed. In the Philippines setting, difficulty in physics topic was supported by Lumapas et al. (2025); the recent study shows that most of the students obtain low scores in physics, especially in electricity and magnetism. In the study by Pardo (2017), various topics in physics were identified as the most challenging to comprehend. Overall, the respondents demonstrated low achievement in physics, and it was observed that those who reported greater difficulty in learning physics concepts also tended to have lower performance in the subject. The overall difficulty of learning Physics was increased by the difficulty of

understanding and communicating concepts (Ebora, 2016). As stated by Camarao et al. (2017), these difficulties contribute to students' low performance and limited comprehension in physics. This serves as an indication that the need for intervention was necessary. In order to enhance students' conceptual understanding, game-based learning, or GBL, has become a popular pedagogical approach which includes interactive elements, characters, and game mechanics into instruction. The pre-game, in-game, and post-game stages are the three separate phases that Bado (2019), claims can be used to understand the integration of GBL. There was a lot of evidence that supports the positive impact of educational games on students' learning results. Hamari et al. (2016) discovered that the inclusion of game elements such as feedback, competition and prizes may promote intrinsic motivation and engagement resulting in improved knowledge retention compared to traditional teaching methods. To aid the difficulties in physics, particularly in the topic of power generation, transmission and distribution, the development of the Bingolectrik game served as an intervention. An intervention to address the difficulties in physics, especially in the area of electrical energy, the creation of the game Bingolectrik. The name Bingolectrik was a combination of the words "Bingo game" and "Electrical Energy." This was to develop an interesting, active learning environment while simplifying the often challenging and complex ideas of electrical energy, such as from power plants (hydroelectric, geothermal, wind, and nuclear) to home. Bingolectrik aims to improve and enhance conceptual understanding by integrating physics challenges and problems into the popular, competitive game of Bingo Learning Material. In the light of the above stated difficulty, the researcher aims to identify the least mastered competencies of learners, develop and evaluate a Bingolectrik card game to enhance conceptual understanding of students.

METHODS

Research Design

The study utilized a Research and Development (R&D) approach to systematically design and implement the educational bingo game as a unique teaching instrument. The study of Umar et al. (2023) states that Research and Development (R&D) Method was one of the best model designs for better educational practices, it was being developed as a result of the expansion of educational research as a branch of science. To evaluate its effectiveness, the study also include a quasi-experimental technique through the administration of one-group pretests and posttests. This approach not only optimizes educational outcomes but also fosters a deeper understanding of the material among learners. ADDIE Model includes, Analysis Stage, Design Stage, Development Stage, Implementation Stage, and Evaluation Stage. In the Analysis Stage, learners' needs for assessment was conducted. The Design Stage focuses on identifying learning competency and learning objectives. During the Development Stage, the real game materials were generated and refined depending on the development criteria. The Implementation Stage involves the administration of the game to students in the classroom. Finally, the Evaluation Stage examines the learning outcomes.

Research Participants

The study was conducted in a public high school during the fourth quarter of School Year 2025–2026 in Iligan City. The needs assessment involved 106 Grade 10 students and Science teachers handling Grade 9 classes to determine the least mastered competencies in Physics. For the pilot testing of the Conceptual Understanding Questionnaire (CUQ), three (3) expert content validators with Master's or Doctorate degrees and at least five years of teaching experience evaluated the instrument, while one hundred (100) students participated in the pilot administration. In the implementation stage, sixty-four (64) Grade 9 students from two purposively selected sections participated in the intervention. The use of purposive sampling was appropriate because the sections were accessible to the researcher and were currently studying the topic on Power Generation, Transmission, and Distribution. Although the sample size was adequate for classroom-based implementation, the findings are limited to the participating school and may not be generalized to all Grade 9 learners.

Data Gathering Procedure (ADDIE Model)

The researcher used ADDIE Model to design and develop Bingolectik Card Game in Power generation, transmission and distribution. This model, integrated with the Research and Development (R&D) approach, ensured a valid and structured design process. Unlike traditional models, the ADDIE model highlights

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adaptability, quick development, and ongoing feedback, resulting in effective and learner-focused learning materials. It consists of five stages: Analysis, Design. Development, Implementation and Evaluation.

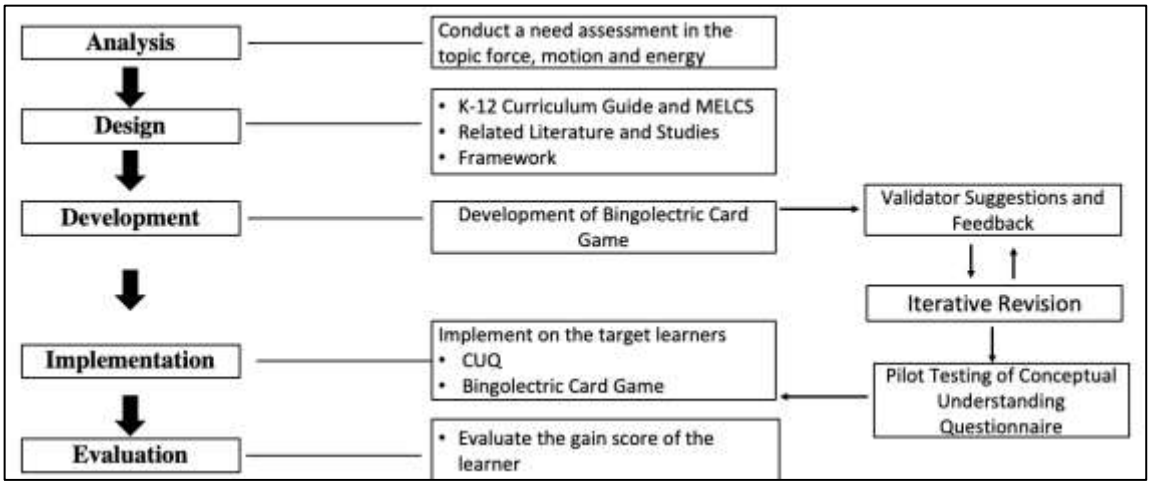


Figure 1. Process of ADDIE

Analysis Stage

During the Analysis Stage, the data gathering procedure focused on identifying learners' needs through measuring their current understanding, and defining the learning competencies and objectives that served as the foundation for developing the instructional material. To identify the specific learning gaps, the researcher performed needs assessment through tests to evaluate students' prior knowledge and conceptual challenges. Furthermore, the researcher reviewed the K–12 Science Curriculum Guide to confirm that the defined capabilities and objectives were compatible with the national learning standards.

Design

In the design of the Bingolectrik Game, the K-12 competences were identified in science especially the ones connected to electrical energy. It also contributed to the exploration and inclusion of restricted real-time events and phenomena, in order to make the learning process more meaningful and relevant to the setting. By aligning the game material to curriculum standards, students would be able to apply their theoretical knowledge to common electrical instances and would therefore be more invested and grasp the content better. Furthermore, the examination of related papers and existing educational interventions ensured that the design integrates evidence-based strategies for promoting conceptual understanding and active involvement in science learning.

Development

In this stage, planning for the structure of educational intervention, and assessment tools of the bingo game happened. The development stage includes creation of card game and creation of assessment tests, science content validator and game design validator reviewed the card game for any corrections and suggestions that may be useful in revising the material and the test. The development of the Bingolectrik Card Game followed a systematic procedure that ensured both pedagogical alignment and student engagement.

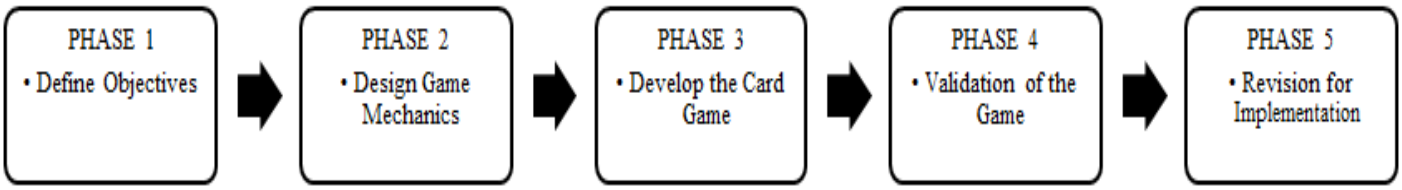


Figure 2. Development Phases of the Card Game

a. The first phase was establishing Learning Objectives. This phase focused on establishing the learning competencies that the game would be targeting in Science 9. Validation of the correctness of the learning content, appropriateness for the age group, and conformity with the national standards was done through the evaluation process of the K-12 Curriculum Guide and relevant literature and contemporary educational games.

b. The second stage, Designing Game Mechanics, involved thinking about how the game were function. In this stage the general framework, rules and scoring system were defined. It was meant to be an individual experience that would challenge a player's decision-making and choices.

c. The third phase, Game Development, focused on constructing the actual game components. The cards developed as answer card, each providing interactive and concept-driven content. The first draft of the Bingolectrik game served as a learning material for testing and modification.

d. In the fourth phase, Validation, the material examined by validators to determine its quality and learning use. In the validation a number of issues were looked at including the game between aims and objectives, the design of the cards, the organization of the components, the playability, the playfulness and the overall usefulness. Input from the validators was essential in identifying areas for improvement to ensure that the game met educational and engagement standards.

e. Finally, the final process, Revision of the Game for Implementation was to revise the Bingolectrik game based on input and evaluation results. The second draft was produced for classroom implementation and learner assessment to examine its impact on students' learning and enjoyment of the topic. This structured development cycle assured that the Bingolectrik Card Game was, overall, pedagogically sound, as well as engaging and successful in increasing learners' conceptual understanding of electrical energy

Implementation Stage

During the implementation, it involves getting consent from School Division Superintendent, the school, parents, and students to guarantee ethical adherence and voluntary involvement. A pre-test was given to see how well the students understand the ideas they are supposed to learn before the intervention. The game was implemented to learners, which lets them use the learning material that was created. After the intervention, it includes giving a post-test to see how much better the students did after playing the game.

Evaluation Stage

The data collected were organized, tabulated, and analyzed using both descriptive and inferential statistics. Descriptive statistics such as mean, percentage, and frequency distribution were used to summarize the learners' performance and validators' evaluation ratings. To determine the effectiveness of the Bingolectrik Card Game, pre-test and post-test scores were compared using normalized gain and paired sample t-test analysis.

Prior to conducting the t-test, assumptions including normality of scores and paired observations were considered. Effect size interpretation through normalized gain analysis was also employed to determine the magnitude of learning improvement among the learners. Reliability measures and validation procedures were likewise utilized to ensure the consistency and accuracy of the research instruments.

Data Analysis

This section presents the statistical tools and procedures used in analyzing and interpreting the data gathered from the respondents. The collected data were organized, tabulated, and analyzed using both descriptive and inferential statistical methods to ensure accurate interpretation of the results.

Needs Assessment

Table 1. Needs Assessment Rating Scale

Rating Scale/Mean	Verbal Interpretation
4.20- 5.00	Fully Mastered
3.40- 4.19	Mostly Mastered
2.60- 3.39	Partially Mastered
1.80- 2.59	Barely Mastered
1.00- 1.79	Not Mastered

For the needs assessment, mean scores and verbal interpretations were utilized to determine the least mastered competencies among Grade 9 Physics topics. The obtained means were interpreted using the established rating scales ranging from "Not Mastered" to "Fully Mastered." This procedure enabled the researcher to identify the content area that required instructional intervention.

Descriptive Evaluation Tool

For the evaluation of the Bingolectrik Card Game, weighted mean scores were computed to determine the validators' assessment of the instructional material in terms of goals and objectives, card design, components and organization, playability and playfulness, and usefulness. The descriptive ratings ranging from "Poor" to "Outstanding" were based on validated evaluation rubrics adapted from instructional material evaluation standards.

Table 2. Descriptive Evaluation of Card Game

Rating Scale/Mean	Verbal Interpretation
4.20- 5.00	Outstanding
3.40- 4.19	Very Satisfactory
2.60- 3.39	Satisfactory
1.80- 2.59	Fair
1.00- 1.79	Poor

Language Evaluation Tool (LRMDS)

Table 3. Standard/ Criterion for Language Evaluation Tool

Standards/ Criterion Items	Note	Verbal Interpretation
Factor I- Coherence and Clarity of though	At least 7 out of 9 criterion items must be marked YES	Complied
Factor II- Grammar and Syntax	At least 5 out of 7 criterion items must be marked YES	Complied

Factor III- Spelling and Punctuation	At least 3 out of 3 criterion items must be marked YES	Complied
Factor IV- Consistency in Style	At least 4 out of 5 criterion items must be marked YES	Complied

In order to make sure that the language used in the instructional material is acceptable for the learners' level of comprehension and in line with the Department of Education's requirements, this scale was used to evaluate the language's appropriateness, clarity, accuracy, and effectiveness. The language validators carefully examined the instructional content to determine whether the statements, instructions, and questions were appropriate for the comprehension level of Grade 9 learners. The validation process focused on the proper organization of ideas, grammatical accuracy, sentence construction, punctuation, and consistency in writing style. In addition, the validators assessed whether the language used in the Bingolectrik Card Game was simple, understandable, and free from ambiguity to promote effective communication of scientific concepts.

Normalized Gain <g>

To measure the effectiveness of the Bingolectrik Card Game, learners' pre-test and post-test scores were analyzed using normalized gain and paired sample t-test analysis. The normalized gain determined the magnitude of conceptual improvement achieved by the learners after exposure to the intervention. The paired sample t-test was utilized to determine whether there was a statistically significant difference between the pre-test and post-test mean scores.

$$< g > = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}}$$

Figure 3.6. Normalize Gain Formula

Table 4. Normalize Gain Interpretation

Classification	**Range**
Decrease	-1.00 <g< 0.00
Stable	g = 0.00
Low <g>	0.00 < g < 0.30
Average <g>	0.70 ≥ g ≤0.30
High <g>	g > 0.7

Performance Rating

The result of the students' pretest and posttest, and learning activity performance were designed in alignment with the K-12 Curriculum Guide. Following the assessment, an item analysis has been performed. This analysis involved the use of both the discrimination index and the difficulty index. After item analysis performed, the researcher identified the following 15 accepted questions which was used in administered pre-test and posttest. The result of the students' pretest and posttest determined 5 (Outstanding); 4 (Very Satisfactory); 3 (Satisfactory); 2 (Fair); to 1 (Poor).

Table 5. Descriptors of Performance

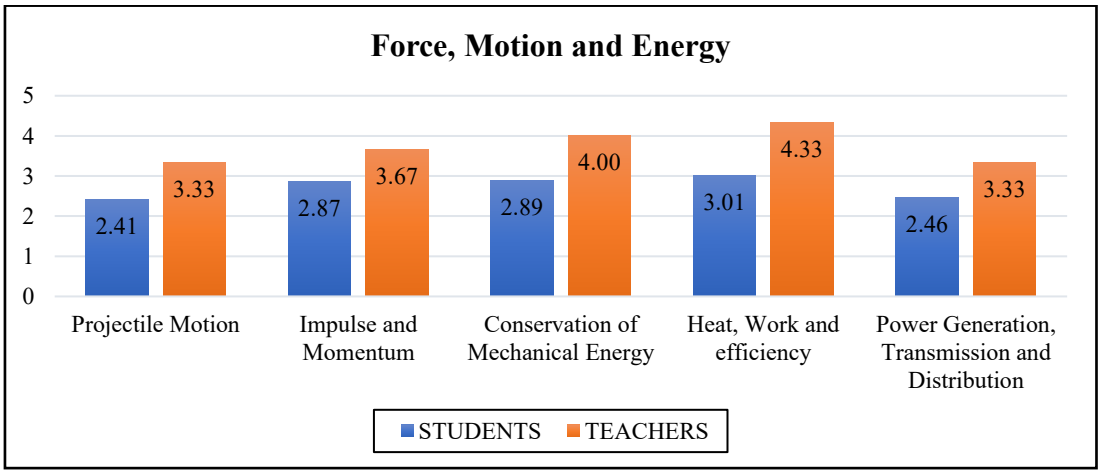
Rating Scale/Mean	Descriptors
90-100	Outstanding
85-89	Very Satisfactory
80-84	Satisfactory
75-79	Fairly Satisfactory
74 below	Did Not Meet the Expectation

RESULTS AND DISCUSSIONS

Analysis Stage

Student and Teacher Least Mastered Competency

In identifying the least mastered topics in physics, the Analysis phase, provides result for determining the specific content areas that require instructional support, particularly in the Force, Motion, and Energy. In this stage a needs assessment was conducted to both learners and teachers.



Legend: 4.20- 5.00 (Fully Mastered); 3.40- 4.19 (Mostly Mastered); 2.60-3.39

(Partially Mastered); 1.80- 2.59 (Barely Mastered); 1.00- 1.79 (Not Mastered)

Figure 3. Comparison of Students and Teachers Needs Assessment

The result of the study reveals that there were gaps between teachers' view of the subject and students' actual needs, where teacher rating competence level higher than students. This gaps arises a possibility that the existing teaching methods and learning materials were not enough to address learning challenges that students face. The study by Sultan et al. (2021), determine that the mastery of teacher to teach the subject and clearly explain the ideas, make an impact on students' conceptual understanding.

Design Stage

The result of analysis for needs assessment, the topic of Power Generation, Transmission, and Distribution resulted as one of the topics needed an intervention due to inadequate learning support. The main goal of this learning material was, after exposing the materials to the students, they could explain how electrical energy was generated, transmitted, and distributed.

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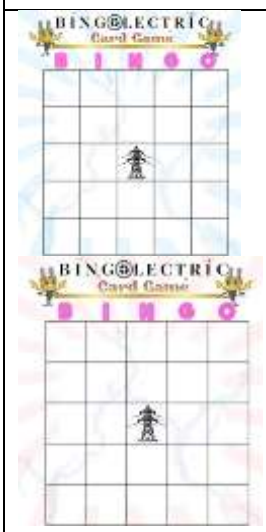
Table 6. K-12 Curriculum Guide

Content	Learning Competency	Specific Objectives
Power Generation, Transmission and Distribution	Explain how electrical energy is generated, transmitted, and distributed	1. Identify different sources of electrical energy (e.g., hydroelectric, geothermal, coal, wind, solar, nuclear). 2. Describe how electricity moves from power plants through high-voltage transmission lines. 3. Explain how electricity reaches homes, schools, and industries through distribution lines.

Development Stage

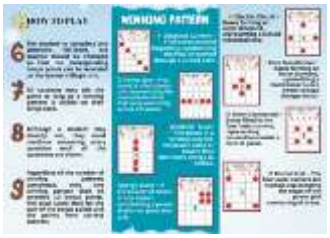
Table 7. Changes in the Bingolectrik Card (Draft 1 and Draft 2)

Draft 1	Comments Suggestions	Draft 2
	• "Use hard and glossy paper so it won't get crumpled and destroy easily" -PV1 • Focus the color of card to "red" for it is more stimulating and exciting color for game/gambling. - PV1 • The Bingo Card Box is too bulky. – PV2	**(Front)**  

The Bingolectrik Card Game underwent series of revisions to improve the design and content of the learning material, the series of improvement presented as feedback-based revision. The first version of the Bingolectrik Card Game had a various color on its background and game mechanics for students was originally planned as separate to the Bingo Card, however it was commended for its low interest, bulky design and low durability. In response, changes were made, including the use of glossy and hard paper, thinner box, and the instead of using various color, the bingo card focused more on color red design as perceived in the study of Pontes & William (2021).

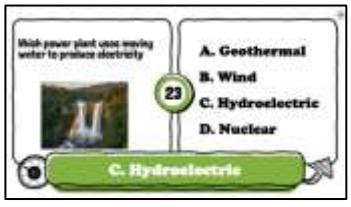
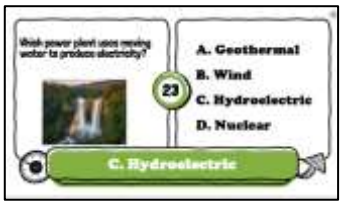
Table 8. Changes in the Game Mechanics (Draft 1 and Draft 2)

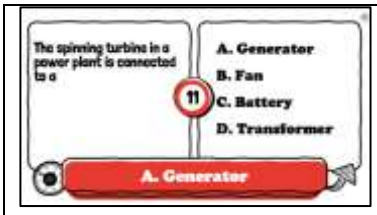
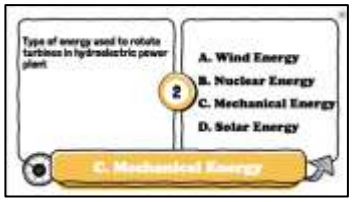
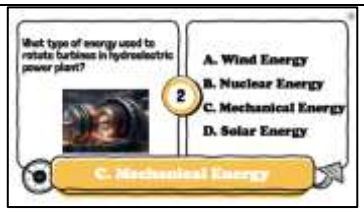
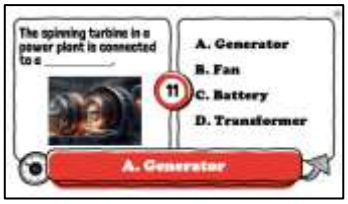
Draft 1	Comments Suggestions	Draft 2
(Front)	• Instead of "X" marked for correct answer used circle "O" to indicate correct answers since, marked "X" usually used to indicate	**(Front)**

 **(Back)** 	incorrect answer. • "…, you may also use stamp toy to indicate correct answer"-PV2 • In mechanics number 5, change the word "Cross" or "Uncrossed" to the word "stamp" or "Unstamped". -PV2 • In mechanics number 7, paraphrase the statement to the statement "All students may win the game as long as a winning pattern is visible on their Bingo card" and "…, only one winning pattern shall be awarded 10 bonus points…"-PV2	 **(Back)** 

The table 8 shows changes in Game Mechanics for teacher. By reinforcing positive learning and clearer education it improves learner's experience, one of the highlight suggestion, was replacing negative connotation like "X" marks with positive symbols which represent usual used as indicator for correct answer like "Circle or Stamp" , this was to avoid confusion of the scores and emphasize correct response in a more encouraging way, Furthermore, comments from validator suggested that the bonus points from a winning pattern should not be the basis for their winning, rather an extra point incentive, this was to decrease competitive pressure and students were not only focused on having winning pattern, rather to answer all questions, supported by the study of Qudsi (2024), giving right point system to the game, teacher could create more interactive and motivating learning environment.

Table 9. Changes in Question Roulettes in PowerPoint Presentation (Draft 1 and Draft 2)

Draft 1	**Comments Suggestions**	**Draft 2**
   	• In slide number 3. and 8, capitalize the word "bingo"-PV3 • Be consistent with the color of the word in the instruction in PPT"-PV2 • Make a discussion about the implication of the color of the word in instruction. ▪ Red- command and important instruction, ▪ Violet- Motivation and encouragement ▪ Green- important academic focus ▪ Yellow- indicate warning or	  

 	reminders. • In slide number 15, put a question mark in the question "Which power plant uses moving water to produce electricity" -PV3 • Be consistent in in putting question mark, colon underline in each question. -PV3	 

Based from validator evaluation, they focused on three areas; consistency, clarity, make sure the instructions were effective. Some comments were about making the format consistent throughout, which include capitalization and punctuation (e.g., use of colons and question mark), validators also wanted figures in all slides. This was ensure that students understand the instructions and questions. Validators also highlighted the use of color coding in instruction this was to enhance engagement and attention through visual organization, where each color has its purpose (red is for commands, violet was for motivation, green is for academic focus, yellow was for warnings).

Table 10. Content Validators Rating Summary on Bingolectrik Card Game

Statement	**Rating (N=5)**	**Description**
Goals and Objective		
1. The purpose and rationale for the game is fully explained.	4.80	Outstanding
2. The goals and objectives of the game are clearly defined.	4.60	Outstanding
3.The game was thought provoking.	4.40	Very Satisfactory
4. The game encourage student interaction.	4.60	Outstanding
5. The game promoted discussion of key topics.	4.60	Outstanding
6. The game will help students to recall of concepts/terms.		
Mean Score	**4.60**	**Outstanding**
Card Design		
7. Card size is appropriate.	4.80	Outstanding
8. Having terms printed on all four sides of the card is a helpful feature for the player's handling of the cards.	4.60	Outstanding
9.The picture printed on the card is representative of the topic.	4.60	Outstanding
10. The material used (paper) in the preparation of the topic.	4.20	Very Satisfactory
11. The deck of cards is compact and can be easily carried around.	4.80	Outstanding
Mean Score	**4.60**	**Outstanding**

Components and Organization		
12. The direction were clear, concise, and easily understood.	4.80	Outstanding
13. The game emphasized key points of the topic played.	4.60	Outstanding
14. The terms used were appropriate to the level of knowledge.	4.80	Outstanding
15. The number of cards was appropriate	4.60	Outstanding
16. It is wonderful and pleasant to use	4.40	Very Satisfactory
Mean Score	**4.64**	Outstanding
Playability and Playfulness		
17. The game provides opportunity for healthy competition and cooperation.	4.20	Very Satisfactory
18. The rules of the game provide players with equal condition for a fair play	4.60	Outstanding
19. The rules of the game provide a set of options for flexibility in making decision when playing the game.	4.40	Very Satisfactory
20. Playing the game was fun	4.60	Outstanding
Mean Score	**4.45**	**Very Satisfactory**
Usefulness		
21. The game was effective in reviewing the material.	4.40	Very Satisfactory
22. The game encouraged the players to dig deeper into the subject matter.	4.40	Very Satisfactory
23. Playing the game is a productive use of time.	4.60	Outstanding
24. Playing the game help establish better relationships among students.	4.40	Very Satisfactory
Mean Score	**4.45**	**Very Satisfactory**

Note: 4.50-5.00 (Outstanding); 3.50- 4.49 (Very Satisfactory); 2.50- 3.49 (Satisfactory); 1.50- 2.49 (Fair); 1.00- 1.49 (Poor)

The Bingolectrik Card Game obtained mean scores ranging from 4.45 to 4.64, interpreted as Very Satisfactory to Outstanding based on the validated rubric used by the content validators. The rubric evaluated the game according to five criteria: goals and objectives, card design, components and organization, playability and playfulness, and usefulness. These findings indicate that the instructional material met acceptable standards in terms of educational relevance, quality, and classroom appropriateness. In particular, the highest ratings were obtained in Components and Organization (4.64) and Goals and Objectives (4.60), suggesting that the mechanics and instructional alignment of the game were clear, organized, and learner-centered. Validators further emphasized that the game mechanics were easy to follow and appropriate for Grade 9 learners, supporting student engagement and conceptual understanding.

Table 11. Validator's Rating Summary on Conceptual Understanding Questionnaire (N=3)

Parameters	Mean Score (30 Item)	Description
Clarity and Balance	3.56	Exceed Expectation
Wordiness	3.60	Exceed Expectation
Appropriateness of Response Listed	3.56	Exceed Expectation
Application to Praxis	3.61	Exceed Expectation
Relationship to the problem	3.64	Exceed Expectation

Note: 3.25-4.00 (Exceed Expectation); 3.24 – 2.50 (Expectation Meet); 2.49 – 1.75 (Below Expectation); 1.74 – 1.00 (Not Acceptable)

Based on Table 11, as evidenced by mean scores ranging from 3.56 to 3.64 on a 4.00-point scale, the questionnaire showed strong content validity. Indicating that the 30-item tool was highly relevant and targeted toward its intended research objectives, The highest rating was achieved in the Relationship to the Problem (3.64), Furthermore, the instrument was not only practically applicable but also well-phrased and concise. Parameters such as Application to Praxis (3.61) and Wordiness (3.60) suggest that With Clarity and Balance and Appropriateness of Response Listed both scoring (3.56), the data confirms that the questionnaire was reliable, well-structured, and clear instrument ready for deployment in assessing conceptual understanding.

Table 12. Language Validators Rating Summary on Bingolectik Card Game

Criterion Item	Description
Coherence and Clarity of Thought	Complied
Grammar and Syntax	Complied
Spelling and Punctuation	Complied
Consistency in Style	Complied

Table 12 showed the summary of the Language Validators' Rating for the Bingolectrik Card Game. The game adhere to all the linguistic standards. The descriptions for all the four criteria of Coherence and Clarity of Thought, Grammar and Syntax, Spelling and Punctuation and Consistency in Style were noted as Complied. This implies that the language used in the game's materials was educationally edited and logically arranged.

Table 13. Comment and Suggestion of Language and Content Validator on Second Draft

Area	Validator	Comments and Suggestion
Language	**LV1**	• The statement from number 4 "Any erased or altered answer is not counted" transfer this to number 5 after the first statement. • Change the statement in number 5 to: a. "If your answer is correct, stamp the number on your
		bingo card or stamp the number on your bingo card if b. your answer is correct" and; c. "If your answer is incorrect. do not stamp the number on your bingo card or do

		not stamp the number on your bingo card if your answer is incorrect". • Change statement to more appropriate questions construction. Following are examples: a. Paraphrase the statement in number 6, to "…, inform your teacher immediately so that your bonus points will be recorded on your bingo card". b. Change the statement in number 7 to "Expect that many, if not all, students may win, as it is possible for two or more students to form winning patterns at the same time c. Rephrase the statement in number 9 to "… Your total points are determined from your winning patterns and the points you get from your correct answer." d. In slide number 11, Transform into question form. • In slide number 53, put the word "its" before the word "neighboring"
Content	**Validator**	**Comments and Suggestions**
	CV1	Well-crafted IM's
	CV2	• In slide number one (1), change the word form "Bingolectric" to "Bingolectrk" and add a tagline "Dare to uncover electromazing facts!". • In slide number 3, add numbers on the card, add the word "Numbers from 1-24 in RANDOM manner" and add the word "Randomly or
	CV3	• The playfulness could be enhanced by incorporating timing, competition, or additional rewards or time-based challenges.
	CV4	• For Card Design: Change the paper card into a hard material (vellum) so it will not be easily crumpled.
	CV5	• In slide number 11, let's not use (produce/create). Law of conservation energy cannot be created nor destroyed-it can only be transformed from one form to another. The answer is obvious, the question has weak distractors • In slide number 13, question needs rephrasing, instead of "Movement of Electron" change to "flow of electrons", it does not create or produce electricity rather change the correct answer to "electric current". • In slide number 15, needs rephrasing, instead of "Movement of Electron" change to "flow of electrons", it does not create or produce electricity rather change the correct answer to "electric current • In slide number 47, change into question form. • In slide number 21, provide correct answer • Change statement to more appropriate questions construction. Following are examples: a. In slide number 19, change the question to "What term describes the delivery

		of electrical power from generating stations to homes and businesses?" b. In slide number 31, change the question to "What component of a hydroelectric power plant is responsible for capturing the energy of rushing water to drive the generator?" c. In slide number 41, change the question to "To what voltage level is the electricity transmitted after it leaves the power plant?

In table 13 the feedback and suggestions made by content and language validators draft of the Bingolectrik Card Game are shown. These results suggests revisions of the learning materials in terms of these thre main aspects:

In terms of linguistic precision, the language validator (LV1) concentrated on enhancing the logical sequence of instructions and grammatical precision. Content accuracy and pedagogy, scientific accuracy and question construction were stressed by content validators (CV2, CV5). In particular, CV5 pointed out that the terminology should be consistent with the Law of Conservation of Energy (i.e. do not "create/produce" energy) and recommended changing "Movement of Electron" to "flow of electrons" to properly express electric current. Engagement and Physical Design, in addition to the game's "playfulness" and durability, validators also noted the physical design. Proposals were made to include a catchy tagline ("Dare to uncover electromazing facts!"), to add competitive features such as time and reward (CV3), and to improve the physical parts from paper to durable material such as vellum (CV4) to prevent damage during student use.

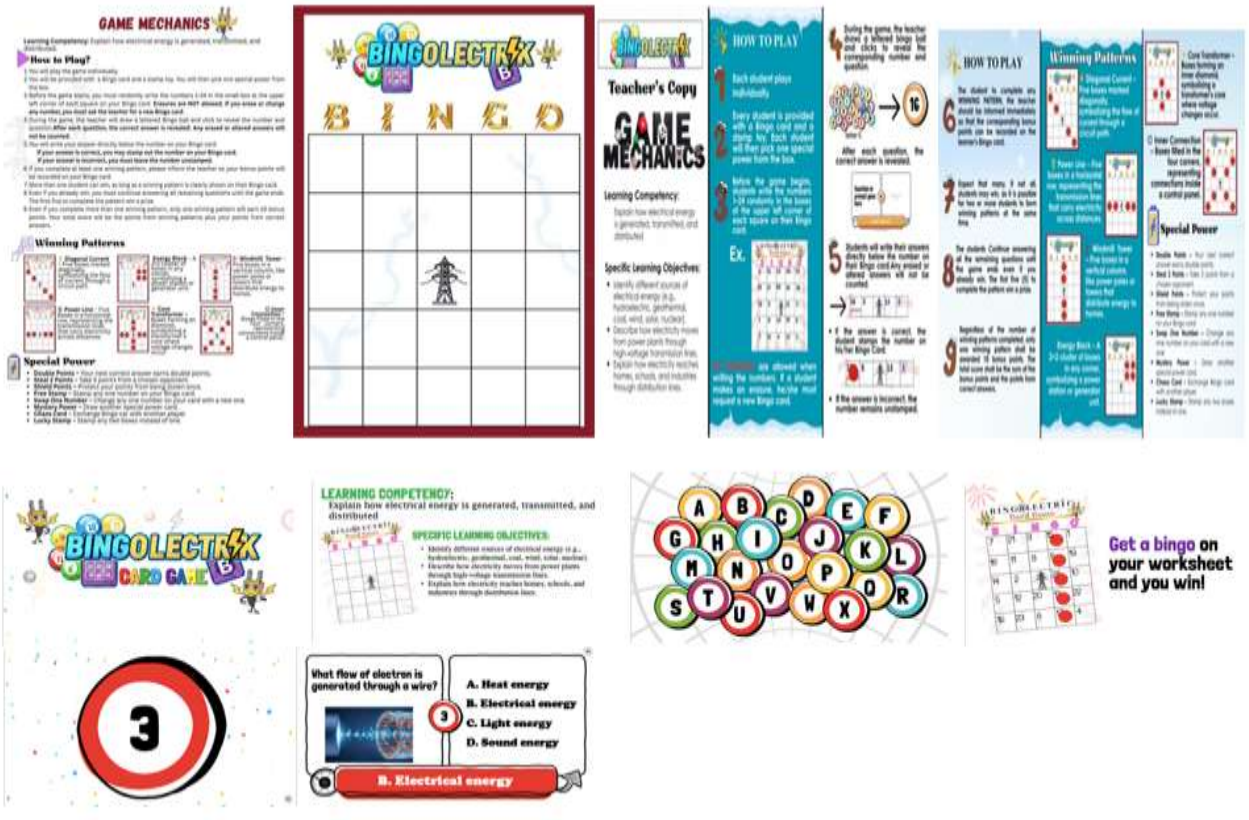


Figure 4. Final Draft of Bingolectrik Card Game

In this section, it showed the final draft of Bingolectrik card game for Grade 9 learners. The sample image was shown including its Bingo card, game mechanics, and question roulette which presented in PowerPoint slide. This materials focused on the topic power generation, transmission and distribution.

Implementation Stage

Table 14. Summary of Learning Activity Performance

Grading Scale (%)	Descriptor	Frequency	Interpretation
90-100	Outstanding	18	Passed
85-89	Very Satisfactory	9	Passed
80-84	Satisfactory	9	Passed
75-79	Fairly Satisfactory	19	Passed
74 and below	Did Not Meet Expectation	9	Failed
TOTAL		64	

The results suggest that the students performed well on the learning activities in general and many learners were in the satisfactory categories. Out of a total of 64 students, 55 passed the exams and the largest groupings were 18 students with Outstanding and 19 students with Fairly Satisfactory grades. The inclusion of students across all positive performance categories (Outstanding, Very Satisfactory and Satisfactory) indicates that the activities were successful in engaging learners with different abilities. Meanwhile, only 9 students were in the Did Not Meet Expectation category, which means that a small number of learners in the class may need additional support. This finding confirmed by research in Game-Based Learning which suggests that interactive learning activities boost students' involvement and performance. Johnson and Johnson (2018) pointed out in a study that interactive and collaborative learning settings greatly improve student conceptual understanding and participation. Similarly, Atiq et. al (2023), stressed that students' engagement with instructional materials results in meaningful learning and improved performance outcomes.

Evaluation Stage

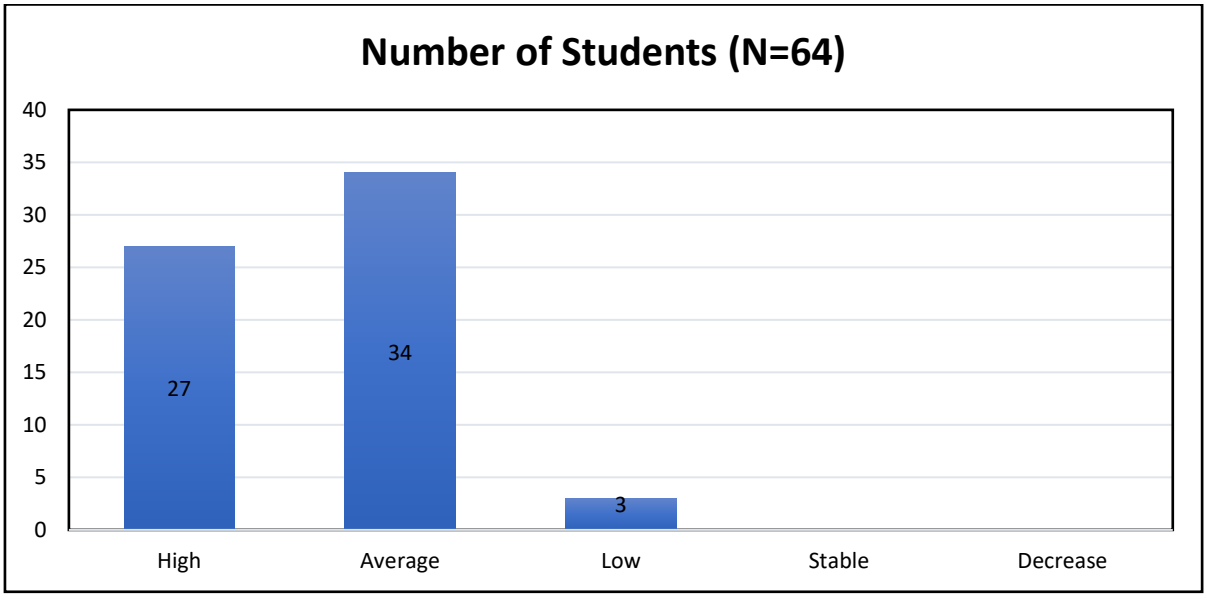


Figure 5. Summary of Normalize Gained Score

Interpretation of Figure 4.4 (Normalized Gain Score) The result of normalized gain indicates that from 64 students, 34 students were in the category of "Average gain", 27 students scored "High gain", and only 3 students got "Low gain". No students were within the "Stable" and "Decrease" categories. Most learners indicated a moderate to high improvement in their conceptual comprehension after the intervention. The high and average gain categories indicate the instruction material (e.g., game-based learning activity) was effective in enhancing the learning outcomes of most students. This result was in accordance with the normalized gain model, which asserts that interactive and student-centered teaching styles generally produce medium to high positive

outcomes, especially when students were engaged in active learning activities rather than passive instruction. The study Himari et. al (2016) supported the result claiming that educational games through game-based learning, improved conceptual understanding through greater engagement and participation.

CONCLUSION AND RECOMMENDATION

The Bingolectrik Card Game was designed and proven as a teaching tool to meet this requirement. The validators gave the game high ratings in terms of design, substance and instructional value which confirms the suitability and efficacy of the game for use in the classroom. Moreover, the deployment of the Bingolectrik Card Game had significantly improved students' in the academic performance of the students as evidenced in the posttest results, normalized gain and the t-test analysis that resulted for the rejection of the null hypothesis. The game was also evaluate positively by the learners and teachers, who found it useful, fun, acceptable and easy to use. Therefore, the study shows that the Bingolectrik Card Game was a reliable, effective, and learner-centered instructional tool that improves the students' engagement and conceptual understanding in Physics. hese findings suggest that game-based learning strategies such as Bingolectrik may contribute positively to student engagement, participation, and conceptual learning in Physics. Despite these positive findings, the study acknowledges several limitations. First, the study utilized purposive sampling and involved participants from only one public high school, limiting the generalizability of the findings to broader populations. Second, the research employed a one-group pretest-posttest design without a control group. Because of this limitation, the observed improvements in learners' performance cannot be attributed solely to the Bingolectrik intervention, as other instructional or environmental factors may have influenced the results. Additionally, while normalized gain and paired sample t-test analyses were utilized, more comprehensive statistical procedures and effect size analyses could further strengthen the interpretation of the findings.

Based on the findings and limitations of the study, several recommendations are proposed. Future researchers are encouraged to employ a more rigorous experimental research design involving both control and experimental groups to better determine the effectiveness of the Bingolectrik Card Game compared to traditional teaching methods. Including larger sample sizes and multiple schools from different learning environments is also recommended to improve the generalizability and external validity of the results. It was recommended that teachers consider using the Bingolectrik Card Game in their teaching practice, particularly in the teaching of difficult concepts in physics, since it has been found to dramatically boost student understanding as well as participation.

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