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Dual Development of Board Game and Guided-Inquiry Activity in Teaching Electricity for Grade 5

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Abstract. The topic on circuits contained abundant misconceptions and there is a need to devise a teaching modality that will possibly address these misconceptions. The way of rectifying misconceptions should be n ways that engender high student engagement and facilitate accommodation of higher order learning and thinking skills. This research sought to develop a two-pronged modality to address both ICT-enabled classrooms and non-ICT enabled ones. A PhET-based laboratory activity and a board game named "Clash on Circuits" were developed and tried on two different public schools to see if an increment of performance can be observed. Eight (8) in-service teachers and four (4) pre-service teachers assessed the laboratory activity using an adapted analytic rubric, while the board game was tried out with selected students for applicability. In the development of the PhET-based laboratory activity and board game Clash on Circuits, the following were gathered: 1) The readability of the final draft of the PhET-based laboratory activity yielded an average of 78.43 Flesch Reading Ease score and 4.6 Flesch Kincaid grade level; (2) Evaluation of in-service to the developed PhEt-based laboratory activity rated the developed laboratory activity as 8.825 in the average which is exemplary and pre-service teachers rated the developed activity as 9.10 in the average which is also exemplary; (3) The readability of the Final Version of the designed board game has 76.2 Flesch Reading Ease score and 6.8 Flesch Kincaid grade level; (4) Evaluation of the in-service rated the developed board game as 3.75 in the average which is exemplary and preservice teachers rated the developed board game as 3.76 in the average which is exemplary; (5) The difference in the pretest and posttest was significant in S1 school implemented with designed board game, and there is no significant difference in the S2 school implemented with both PhET-based laboratory activity and designed board game; and (6) the respondents' perceptions from both schools S1 and S2 towards the developed laboratory activity and board game was 5.94 and 6.08 respectively, which was relatively too high and has very positive implication.

Keywords: Board game, Computer simulation, Laboratory activity, Circuits

INTRODUCTION

Expanse of the universe offers wide array of explorations. On earth, every human being strives to survive either by simple means or by scientific investigations. A formal investigation in science involves a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe, by which the educational sector conducts laboratory activities—distinctive and central focus in science curriculum. Early 1960's practical work in science education marked the students' engagement in various investigations, discoveries, inquiries and problem-solving activities hence laboratory became the center of science teaching and learning environment. Recently, the educational reform of spiral progression highlights the four (4) sciences to be taught at different quarters starting Grade 3 to Grade 10. Existing literatures support the abundance of misconceptions in different Physics topics and the need to address it at even earlier grades is an imperative. One such topic is on Direct Current Circuit. Experiences in teaching the subject electricity to prospective science teachers revealed that even after systematic and fairly advanced study in college, students were found to be incapable of qualitatively analyzing simple circuits. Gaining conceptual understanding in electricity seems to be very challenging and difficult for students in various school levels. Numbers of studies conducted worldwide indicate that students still have many difficulties and misunderstandings after systematics instruction (Fredette & Lochhead, 1980; Shaffer & McDermott, 1992; Duit & von Rhoneck, 1998). Most common difficulties were due to incomplete understanding of the abstract concepts, such as electric current and electric potential, and where Electricity had been a difficult concept for students because of its being an unseen component—an abstract topic where visualization is needed. Teachers need to help students understand what is happening in an electric circuit and explain its concept clearly. Analogy is also a powerful cognitive mechanism used to learn new abstractions, in the form of text, pictures, videos, and verbal perceptions, where unobservable relationship compromising the phenomenon may be depicted via computer simulations. Such computer simulations have special value as they offer high potentials for interactive learning in all domains of science education, but prior researches had demonstrated either effective or insufficient student learning-most often, when dealing with direct current circuits.

Therefore, practical laboratory activities to explore circuit connections, current, voltage and resistance need to be enhanced for maximum internationalization of the subject matter. Visual simulation would be employed as alternative learning environment by using simulation software called Circuit Construction Kit (CCK). However, 20th century education focused on rote memorization and acquired skills (reading, writing, calculation, history, science), and ability to think through and solve complex problems, or interact critically through language or media must be raised to a higher level of learning. One effective way to learn would be the employment of games to naturally support this form of education; this is according to the Institute of Play. So, game playing is an excellent way to help wire our brains in ways that are crucial to the what, why, and how of learning needs for the 21st century. It was in this premise that this research undertaking was conceptualized and developed with eight (8) in-service teachers and four (4) pre-service teachers to assess designed laboratory activity using a rubric. The in-service teachers were public school teachers handling Science subjects. The Pre-service teachers were 4th year physics students of Mindanao State University-Iligan Institute of Technology, 1st semester of A.Y. 2015-2016. This study was conducted at Doña Juana A. Lluch Memorial Central School and at North 1 Central School with one (1) class of Grade VI pupils per school. The respondents had performed the PhEt-based laboratory activity- with focus on developing a PhETbased laboratory activity and game board in teaching direct current circuits.

RESEARCH OBJECTIVES

This study, which aimed to develop a PhET-based laboratory activity and game board in teaching direct current circuits, sought to answer the following questions:

1. What was the readability of the designed PhET-based laboratory activity?
2. What was the general evaluation of the PhET-based laboratory activity by the pre-service and in-service teachers in terms of:
    a. Title
    b. Objectives
    c. Introduction
    d. Procedure
    e. Educational Value
3. What was the readability of the Mechanics of the developed board game *Clash on Circuits?*
4. What was the general evaluation of the board game Clash on Circuits by the pre-service teachers and student respondents in terms of:
    a. Content
    b. Creativity
    c. Rules and Instructions

METHODOLOGY

This part deals with methods and procedures used in this study. It includes the subject of the study, research design, methods and techniques, instruments in data gathering, and the statistical tools employed in the conduct of this research undertaking.

A. Laboratory Activity

• *Participants*

Eight (8) in-service teachers and four (4) pre-service teachers assessed the design laboratory activity using a rubric. The in-service teachers were all public-school teachers handling Science subjects. The Pre-service teachers were all 4TH physics students of Mindanao State University-Iligan Institute of Technology, 1st semester of A.Y. 2015-2016. This study was conducted at Doña Juana A. Llunch Memorial Central School and North 1 Central School with one (1) class of Grade VI pupils per school.
The respondents performed the PhET- based laboratory activity.

• *Research Design*

This study was qualitative with quantitative research that utilized the research and development design. Purposive sampling was used in selecting the in-service and pre-service teacher respondents and student respondents. Formative assessment through face validation was made by the thesis adviser and panel members.

• *Research Tools*

The Learning Competency of the laboratory activity was based on the K-12 Curriculum Guide. Readability was measured using the Flesch-Kincaid Readability Test to determine if the designed PhET-based laboratory activity was suitable for students of grade levels five and six. To measure the performance of the students, a pretest and posttest in the form of a multiple-choice test questionnaire was given. A rubric was used to assess the designed PhET-based laboratory activity and to determine the students' attitude towards the laboratory activity.

Stage 1: Development of Laboratory Activity

The development of the laboratory activity consisted of three stages, the first draft, second draft, and the final draft.

Designing Laboratory Activity

The topic was about electricity, more specifically about circuits. This was adapted from the K to 12 Basic Education Curriculum Guide in Science for Grade V. The objective of this study was taken from the learning competency found in the curriculum guide.

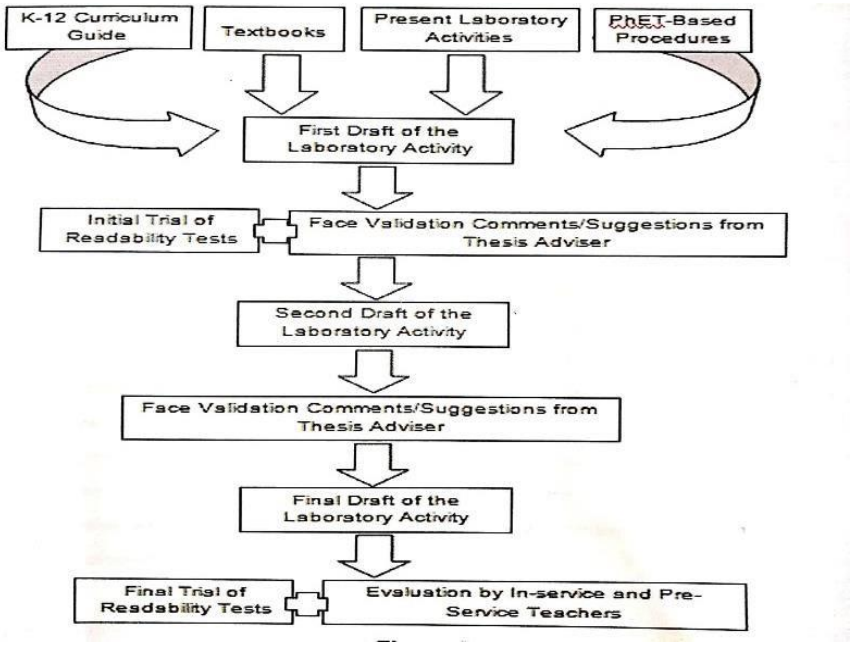

Figure 1 Conceptual Framework of Stage 1: Development of Laboratory Activity

The laboratory activity was developed based on PhET software, the Circuit Construction Kit (CCK). The procedures were designed with step-by-step process on how to manipulate the CCK. The students will have to construct a simple circuit using the CCK to light up a bulb. They investigated on changing the number or type of components, like battery or bulbs, if circuit could make a bulb brighter and dimmer. The mode working on the circuit was by dragging the circuit parts and putting it all together by simply connecting end to end, thereby reducing the usual inconvenience of actual objects. Thus, activity time was considerably reduced, since the assembly only needed to drag the pieces and connecting end to end.

Table 1 Mean Rating Descriptor for the Developed Laboratory Activity

Class Limits	Class Boundaries	Descriptor
1-2	1-2.5	No Evidence
3-4	2.6-4.5	Needs Improvement
5-6	4.6-6.5	Good
7-8	6.6-8.5	Satisfactory
9-10	8.6-10	Exemplary

B. Board Game

• *Participants*

The three (3) pre-service teacher respondents and all student respondents assessed the designed board game using a rubric. The pre-service teachers were all 4th year students of Mindanao State University- Iligan Institute of Technology, 1st semester of A.Y. 2015-2016. This study was conducted at Doña Juana A. Lluch Memorial Central School and at North 1 Central School with one (1) class of Grade VI pupils per school. The respondents performed the designed boardgame.

• Research Design

This study was a qualitative with quantitative research that utilized the research and development design. Purposive sampling was used in selecting the in-service and pre-service teacher respondents and student respondents. Formative assessment through face validation was made by the thesis adviser and panel members.

• *Research Tools*

The Learning Competency of the board game was based from the K to 12 Curriculum Guide. The readability was measured using the Flesch-Kincaid Readability Test to determine if the designed board game was suitable for students of grade levels five and six. To measure the performance of the students, a pretest and posttest in the form of a multiple-choice test questionnaire was given. A rubric was used to assess the designed board game and to determine the students' attitude towards the board game.

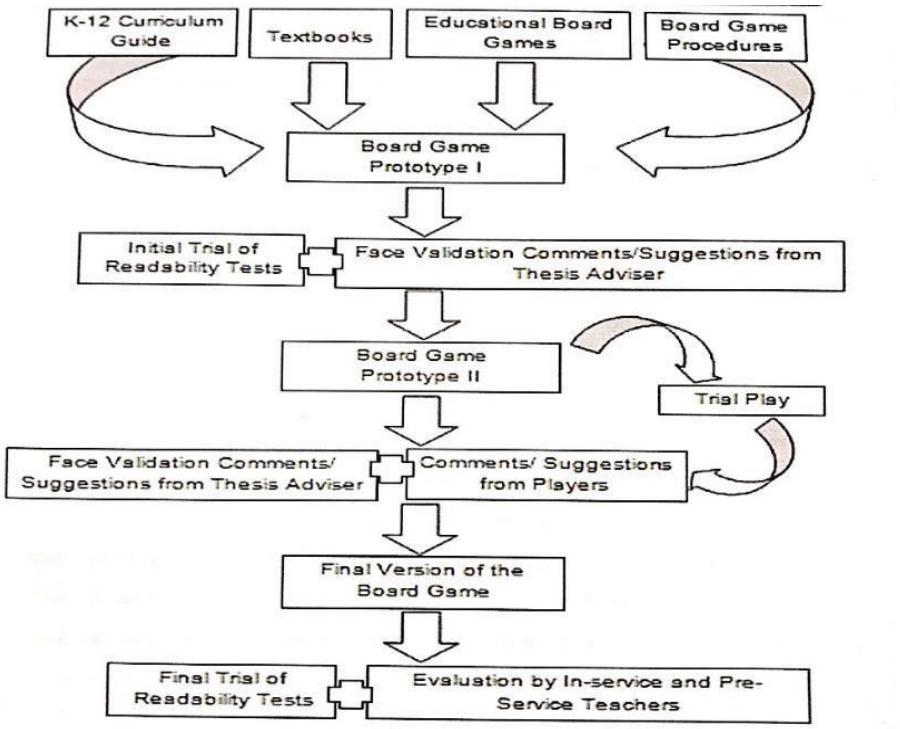

Figure 2 Conceptual Framework on Stage 1: Development of Board Game

Stage 1: Development of Board Game

The development of the board game composed of three stages, the Prototype 1, and Prototype II, and the final version of the Clash on Circuits board game. Each prototype consisted of one set of the board game, per set contains eight (8) elements: (1) Game board, (2) Tokens or player pieces, (3) Mechanics of the board game, (4) Dice, (5) Score sheet, (6) Question Cards, (7) Chance Cards, and (8) Circuit components.

Designing the Board Game

A prototype game board was designed based on the well-known board game Monopoly™, questions used in the game were taken from elementary textbooks, internet sources, and various test papers and quizzes. The questions were compiled, and were then categorized into four (4) following categories: Very Very Easy, Very Easy, Easy and Prominent Persons in Physics. Each category had its corresponding point/s if the question was answered correctly. The objective of the board game was to deliver a different learning environment where students could enjoy the static environment of circuits derived from the dynamic environment of PHET Simulation on Circuits.

The first draft's readability was tested using the Flesch Kincaid Readability Test. After the readability test, it was then face validated by the Thesis Adviser.

Table 2 Face Validation Comments and Suggestions on Prototype 1

Parts of the Board Game	Face Validation Comments/ Suggestions	Revision Done
Question Boxes	The questions were inorganized. They were placed below the question box.	The questions were placed in a separate box and organized per category.
Chance Boxes	The number of chance boxes were very limited.	Chance boxes were added in the game board.
Tokens	The tokens used were not child-friendly.	Cartoon characters with electric powers were printed to be used as tokens.

The revision of Prototype 1 was completed by incorporating suggestions from the evaluators as seen in Table 2 and improving the readability score of the mechanics of the board game, Prototype II was again checked and examined by the thesis adviser and the initial respondents who were BEED Science & Health senior college students. This resulted to another set of comments and suggestions which included the following: instead of using paper as the game board, the evaluators advised the researchers to layout the board game for tarpaulin printing; each question should have corresponding score, the number of components a player had should not be the basis in winning, the points in score sheets should be in place; and some trivia should be placed in the questions.

Table 3 Face Validation Comments and Suggestions on Prototype II

Parts of the Board Game	Face Validation Comments/Suggestions	Revision Done
Game Board	The paper game board was not durable.	The researchers lay out the game board and printed it in a tarpaulin, making it more durable.
Mechanics	The basis of winning, which was based on the number of components collected, was quite unfair. If a student collects a component	There are two ways that a player can win the game: (1) if the players has collected the

Parts of the Board Game	Face Validation Comments/Suggestions	Revision Done
	through a question card, he/she can lose it through jail or return component boxes.	required number of components;
	The font used in the questions are too bold, it should be changed to something more childfriendly.	(2) another basis of winning was through a score sheet, wherein each category of questions was given a corresponding number of points. The font was changed to a more child-friendly font, Comic Sans MS.

After incorporating the revisions on Prototype II, the final game board was produced. The final draft's readability was again tested using the Flesch Kincaid Readability Test.

Table 4 Mean Rating Descriptor for the Developed Board Game

Class Limits	Class Boundaries	Descriptor
1	1-1.5	Needs Improvement
2	1.6-2.5	Good
3	2.6-3.5	Satisfactory
4	3.6-4	Exemplary

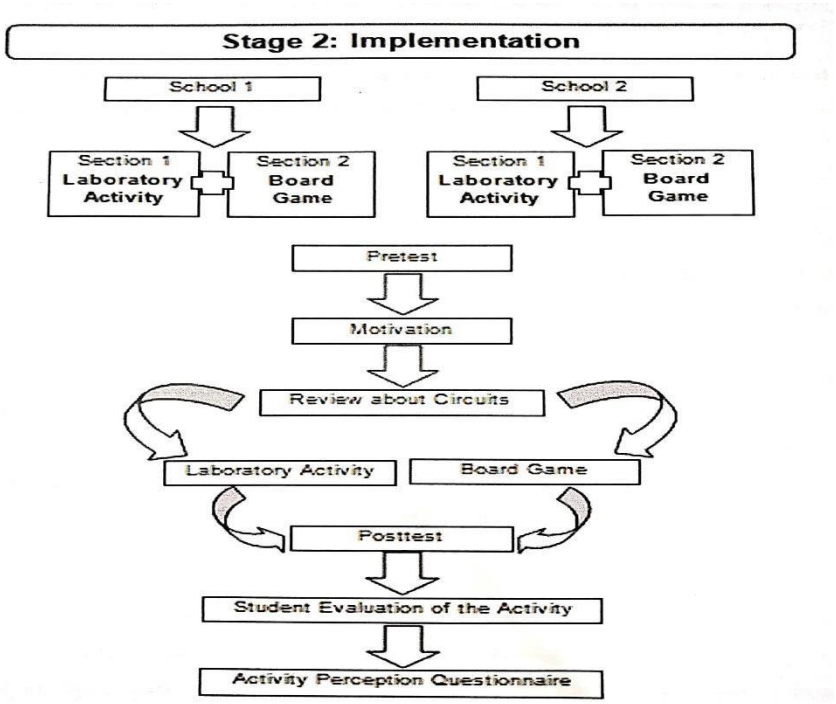

Figure 3 Conceptual Framework on Stage 2: Implementation

Stage 2: Implementation of the Laboratory Activity and Board Game in the Classroom

Two (2) classes from Doña Juana A. Lluch Memorial Central School and North 1 Central School were the student respondents of this study. The data gathering procedure was based on a Lesson Plan made by the researchers. First, a pretest was given to the class to determine the students' prior knowledge about the topic. Next, the class started with motivation about the topic through a game. Afterwards, a short review about circuits was conducted. The Power Point presentation used in the motivation and review could be seen in Appendix. Then, the designed activity, which was either the PhET-based laboratory activity or the board game, was facilitated. After that, the respondents were given posttest in order to measure the learning as a result of the course experience. Subsequently, analytic rubric was given to the respondents for them to evaluate the activity already done. Lastly, in order to measure the respondents' perceptions about the activity, they answered the activity perception questionnaire.

Table 5 Mean Rating Descriptor for the Activity Perception Questionnaire

Class Limits	Class Boundaries	Descriptor
1-2	1-2.5	Not all true
3-5	2.6-5.5	Somewhat True
6-7	5.6-7	Very True

DATA ANALYSIS

After the administration of the lesson, the researchers recorded and analysed the data that were gathered. The following were the statistical tools used in the data analysis of this study.

1. The **mean** was used to qualitatively measure the arithmetic average of the sets of data.

$$\overline{X} = \frac{\Sigma X}{n}$$

Where,

$\overline{X}$ = mean

ΣX = summation of the values and scores

n = number of respondents

2. The **standard deviation** was used to assess the student's performance in their pre-test and post-test.

3. The **T-Test** was used to determine if there was a significant difference in the students' performance in their pre-test and post-test scores.

RESULTS AND DISCUSSION

This part presents the analysis and interpretation and the data gathered by the researchers.

Development of the Laboratory Activity and Board Game

- *Readability of the Designed Laboratory Activity*

The readability of the laboratory activity was measured to make sure that the designed activity was suitable for Grade VI pupils. In measuring the readability of the designed laboratory activity, the Flesch Reading Ease and Flesch-Kincaid Grade Level were used.

The Flesch Reading Ease and Flesch-Kincaid Grade Level were readability tests designed to assess the suitability of reading passages for students at a particular grade level. These two tests have the same core of measures. However, they have different weighing factors.

First Draft

The first draft of the laboratory activity was tested for its readability. Afterwards, it was printed for face validation of the adviser and panel members. Some changes were suggested by the evaluators. Moreover, some graphics or illustrations were added to make the laboratory activity more relevant and interesting to the readers. Notes and word banks were placed were placed in order to provide students with explanation so that ideas will be expounded.

Final Draft

After incorporating the revisions on the second draft, the final laboratory activity was produced by the researchers. Afterwards, it was tested for its readability and evaluated by the pre-service and in-service teacher respondents.

Evaluation of Pre-Service and In-Service Teachers on the Developed Laboratory Activity

Table 6 In-service Teachers' Ratings on the Developed Laboratory Activity

CRITERION	MEAN RATING	DESCRIPTION
Title	8.125	Satisfactory
Objective	9.125	Exemplary
Introduction	8.75	Exemplary
Procedures	8.75	Exemplary
Educational Value	9.375	Exemplary
Overall	**8.825**	**Exemplary**

Table 6 presents the ratings of the In-Service teacher respondents on the developed laboratory activity. They rated the Title as Satisfactory while the rest of the categories were rated exemplary.

Table 7 Pre-service Teachers' Ratings on the Developed Laboratory Activity

CRITERION	MEAN RATING	DESCRIPTION
Title	8.75	Exemplary
Objective	8.75	Exemplary
Introduction	9.5	Exemplary

Procedures	9.25	Exemplary
Educational Value	9.25	Exemplary
Overall	**9.10**	**Exemplary**

Table 7 presents the ratings of the Pre-Service teacher respondents on the developed laboratory activity. They rated the rest of the categories as Exemplary.

The overall rating of the developed laboratory activity for the In-Service and Pre-service teacher respondents was Exemplary. This implies that the developed laboratory activity's title conveyed purpose or significance of the activity; the objective was conceptually correct, concise, specific and clear, and it used correct technical terminology and grammar; the Introduction was well-organized clearly presented and interesting, it integrated information from various sources, and provided a solid basis for doing the experiment; the Procedures included investigative elements that prove and stimulate conceptual understanding; and the Educational Value of the Laboratory activity was exemplary. The questions encouraged breadth and deeper understanding; the information provided selectively encourages thinking.

Teacher's Comments and Suggestions on the Developed Laboratory Activity

a. In-Service Teachers. Below are the comments and suggestions of some In-Service Teachers:

"Visually attractive, it must be emphasized whether the activity is individualized or group activity, the title of the activity must be clear not hanging." (IS_1)

"The activity is good but what if the net availability is limited?" (IS_2)

"Please consider my suggestion. Think about sir and ma'am." (IS_3)

"The laboratory activity is very interactive and interesting. These will spark the student's interest for the lesson." (IS_4)

b. Pre-Service Teachers. Below are the comments and suggestions of some Pre-Service Teachers:

"In using this type of learning tool, student's computer literacy should consider greatly." (PS_4)

Readability of the Mechanics for the Designed Board Game

The readability of the board game was measured to make sure that the designed activity would be suitable for VI pupils. In measuring the readability of the designed board game, the Flesch Reading Ease and Flesch-Kincaid Grade level were used.

Prototype I

The first draft of the mechanics for Prototype I was tested for its readability. Afterwards, it was printed for face validation of the adviser wherein some changes were suggested.

Final Version

After incorporating the revisions on Prototype II, the final game board was produced. Afterwards, the mechanics of the final version was tested for its readability and evaluated by the pre-service and in-service teacher respondents.

Evaluation of Pre-Service Teachers and Students Respondents on the Developed Board Game

Table 8 Pre-Service Teachers' Ratings on the Developed Board Game

CRITERION	MEAN RATING	DESCRIPTION

Content	4	Exemplary
Creativity	4	Exemplary
Rules and Instructions	3.33	Satisfactory
Cooperative Effort	3.67	Exemplary
Overall	**3.75**	**Exemplary**

The table 8 presents the ratings of the pre-service teacher respondents on the developed board game. They rated the rules and instructions as Satisfactory, and the rest of the categories as Exemplary. This maybe because words used in the rules and instructions of the board game were not appropriate for the respondents based on the Flesch Kincaid Grade Level.

Table 9 Students' Ratings on the Developed Board Game

CRITERION	MEAN RATING	DESCRIPTION
Content	3.77	Exemplary
Creativity	3.86	Exemplary
Rules and Instructions	3.77	Exemplary
Cooperative Effort	3.64	Exemplary
Overall	**3.76**	**Exemplary**

Table 9 presents the ratings of the student respondents on the developed Board Game. They rated all of the categories as Exemplary.

The over-all rating of the developed Board Game for the Pre-Service teachers and student respondents was Exemplary. It could be implied that the developed Board Game's Content presented high level of information and facts; high level of creativity was used to make the board game informative and appealing; the rules and instructions were-developed and easy- to-follow; and students contributed high level of cooperative effort in playing the Board Game.

Teachers' Comments and Suggestions on the Developed Board Game

a. Pre-Service Teachers. Below are the comments and suggestions of some Pre-Service Teachers:

"Very Creative." (PS_1)

b. Student Respondents. Below are the comments and suggestions of some Student Respondents:

"I want the monopoly game again. It is very fun that game but is lacking of time." (S_1)

"The lesson is all about the circuit. I learn that the components of the circuit are bulb, copper wire, switch, dry cell. The activity was very fun and exciting especially when the game started." (S_2)

"I think we should be given more time to play the game because it is full of knowledge and very fun especially with the questionnaires." (S_3)

"I think this game enjoyable than Clash of Clans because Clash of Circuit is fun to know more about circuits for knowledge." (S_4)

"I think we should be given more time to play the game because it was very enjoyed and we learn many things about the different kinds of circuit." (S_5)

"In jail it a little bit an unfair I would like to add that if you in jail have no components shall have punishment or something to do after the game. It is my only

opinion po:).” (S_6)

Mean Test Scores of the Students in School 1 (S_1) and School 2 (S_2)

Table 10 Data Gathered for the Developed Laboratory Activity and Board Game

School 1				
Descriptive Statistics	**PhET-Based Laboratory Activity**		**Clash on Circuits Board Game**	
	Pretest	Posttest	Pretest	Posttest
Count	36	36	44	44
Mean	7.75	9.53	11.18	12.64
Sample Variance	4.48	3.34	8.76	7.07
Sample Standard Deviation	2.12	1.83	2.96	2.66
Minimum	3	5	5	7
Maximum	12	12	17	18
Range	9	7	12	11

Table 10 presents the descriptive statistics of the developed Phet-Based laboratory activity and board game Clash on Circuits of the students from School 1 (S_1). The posttest mean was greater than the pretest mean. The scores in the posttest became more homogenous as the standard deviation deceased. This means the scores in the posttest became more clustered compared to pretest. Although the board game group has bigger score mean compared to PhET-based laboratory activity.

Table 11 Data Gathered for the Developed Laboratory Activity and Board Game

School 2				
Descriptive Statistics	**PhET-Based Laboratory Activity**		**Clash on Circuits Board Game**	
	Pretest	Posttest	Pretest	Posttest
Count	33	33	33	33
Mean	8.67	9.70	10.85	11.39
Sample Variance	5.85	4.84	8.76	8.06
Sample Standard Deviation	2.42	2.20	2.96	2.84
Minimum	4	6	6	6
Maximum	13	14	18	18
Range	9	8	12	12

Table 11 presents the descriptive statistics of the developed PhET-Based laboratory activity and board game Clash on Circuits of the students from School 2 (S_2). The posttest mean was greater than the pretest mean. The scores in the posttest became more homogenous as the standard deviation decreased. The scores in the board game group were much higher than that of PhET group. There was parallelism in the result of schools S_1 and S_2.

What is common to both schools was that the scores in the posttest was bigger compared to pretest whether PhET of board game classroom. The scores in the posttest were more homogenous compared to the pretest. The posttest scores of board game classroom were higher compared to PhET classroom.

T-test Results of the Developed Laboratory Activity and Board Game in the School 1 (S_1)

Table 12 T-Test Results of the Developed Laboratory Activity and Board Game

School 1		
Hypothesis Test: Independent Groups (t-test, unequal variance)		
	PhET-Based Laboratory Activity	**Clash on Circuits Board Game**
Pretest mean	7.75	11.18
Posttest mean	9.53	12.64
Difference (Posttest-Pretest)	1.778	1.455
P-value (two-tailed)	**.0003**	**.0174**

Table 12 presents the T-test results of the developed PhET-Based laboratory activity and board game Clash on Circuits of the students from School 1 (S_1).

There was a significant difference between the pretest and posttest scores of the students of School 1 (S1) who performed the laboratory activity and board game, since p value was less than 0.05.

T-test Results of the Developed Laboratory Activity and Board Game in the School 2 (S_2)

Table 13 T-Test Results of the Developed Laboratory Activity and Board Game

School 2		
Hypothesis Test: Independent Groups (t-test, unequal variance)		
	PhET-Based Laboratory Activity	**Clash on Circuits Board Game**
Pretest mean	8.67	10.85
Posttest mean	9.70	11.39
Difference (Posttest-Pretest)	1.030	0.545
P-value (two-tailed)	**.0751**	**.4477**

Table 13 presents the T-test results of the developed laboratory activity of the students from School 2 (S_2).

There was no significant difference between the pretest and posttest scores of the students of School 2 (S_2) who performed the laboratory activity, since p value was greater than 0.05.

Students' General Perception Towards the Developed Laboratory Activity

Table 14 Students' Perception on the Developed Laboratory Activity

ACTIVITY PERCEPTION QUESTIONNAIRE		
Statement	**Mean Rating**	**Descriptor**
1. I believe that doing this activity could be of some value for me.	6.61	VT
2. I believe I had some choice about doing this activity.	6.04	VT
3. While I was doing the activity, I was thinking about how much I enjoyed it.	6.21	VT
I believe that doing this activity is useful for improved concentration.	6.48	VT
5. This activity was fun to do.	6.29	VT
6. I think this activity is important for my improvement.	6.43	VT
7. I enjoyed doing this activity very much.	6.47	VT
8. I really did not have a choice in doing this activity.	2.69	NAAT
9. I did this activity because I wanted to.	5.67	ST
10. I think this is an important activity.	6.49	VT
11. I felt like I was enjoying the activity while I was doing it.	6.56	VT
12. I thought this was a very boring activity.	2.55	NAAT
13. It is possible that this activity could improve my studying habits.	5.66	ST
14. I felt like I had no choice but to do this activity.	2.90	NAAT
15. I thought this was a very interesting activity.	5.98	ST
16. I am willing to do this activity again because I think it is somewhat useful.	6.67	VT
17. I would describe this activity as very enjoyable.	6.63	VT
18. I felt like I had to do this activity.	6.56	VT
19. I believe doing this activity could be somewhat beneficial for me.	6.12	VT
20. I did this activity because I had to.	5.79	ST
21. I believe doing this activity could help me do better in school.	6.51	VT
22. While doing this activity, I felt like I had choice.	5.86	ST
23. I would describe this activity as very fun.	6.84	VT
24. I felt like it was not my own choice to do this activity.	4.32	ST
25. I would be willing to do this activity again because it has some value for me.	6.97	VT
Overall Mean	5.94	ST

**Scores of these items are reversed*

Legend: 5.6-7 ***Very True***

2.6-5.5 ***Somewhat True***

1-2.5 ***Not At All True***

The students perceived that the activity was fun to do and very enjoyable. They believe that doing the activity is valuable. The students did the activity because they wanted to. They enjoyed the activity while doing it. The activity was not boring and could improve the students' study habits. The activity could help the students do better in school. The respondents' perception of the developed laboratory activity was 5.94 which was relatively too high and as very positive implication.

Students' General Perception towards the Developed Board Game

Table 15 Students' Perception on the Developed Board Game

ACTIVITY PERCEPTION QUESTIONNAIRE		
Statement	**Mean Rating**	**Descriptor**
1. I believe that doing this activity could be of some value for me	6.76	VT
2. I believe I had some choice about doing this activity.	5.56	ST
3. While I was doing the activity, I was thinking about how much I enjoyed it.	6.63	VT
4. I believe that doing this activity is useful for improved concentration.	6.70	VT
5. This activity was fun to do.	6.85	VT
6. I think this activity is important for my improvement.	6.77	VT
7. I enjoyed doing this activity very much.	6.68	VT
8. I really did not have a choice in doing this activity.	2.36	NAAT
9. I did this activity because I wanted to.	5.91	ST
10. I think this is an important activity.	6.44	VT
11. I felt like I was enjoying the activity while I was doing It.	6.72	VT
12. I thought this was a very boring activity.	2.55	NAAT
13. It is possible that this activity could improve my studying habits.	6.65	VT
14. I felt like I had no choice but to do this activity.	2.32	NAAT
15. I thought this was a very interesting activity.	5.59	ST
16. I am willing to do this activity again because I think it is somewhat useful.	6.64	VT
17. I would describe this activity as very enjoyable.	6.73	VT
18. I felt like I had to do this activity.	5.93	ST
19. I believe doing this activity could be somewhat beneficial for me.	6.67	VT
20. I did this activity because I had to.	6.67	VT
21. I believe doing this activity could help me do better in school.	4.65	ST
22. While doing this activity, I felt like I had choice.	6.64	VT
23. I would describe this activity as very fun.	5.69	ST
24. I felt like it was not my own choice to do this activity.	6.83	ST
25. I would be willing to do this activity again because it has some value for me.	2.76	NAAT
Overall Mean	**6.88**	**VT**

The students would be willing to do the activity again because they believe it is valuable. The activity was extremely fun for students. It was the students' own choice to do the activity. The students enjoyed the activity. The perception of the respondents towards the designed board game was 6.08 which was relatively too high and has very positive implication.

The students perceived both activities as exceptionally fun and enjoyable. Apart from the activities' entertainment significance, the students were willing to do the activity again because both were valuable. The respondents' perception towards both activities was comparatively too high and has an extremely positive implication.

CONCLUSION

In the review of forgoing findings, the researchers hereby arrive to the following conclusions:

1. The developed PhET-based laboratory activity is easy to read and very appropriate for Grade 5 students.
2. The developed board game "Clash on Circuits" is fairly easy to read and appropriate for Grade 7.
3. The grade level of the board game "Clash on Circuits" does not hinder the engagement and the enthusiasm, performance of the pupil respondents based on their perception to the activity as well as posttest result.
4. The PhET-based laboratory activity has the capacity to enhance cognitive understandings.
5. The designed board game "Clash on Circuits" has the capacity to enhance cognitive understandings.

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Appendix 1

A. Final Draft of the Laboratory Activity (Research Instrument)

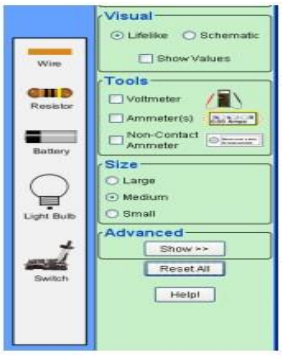
Names: _____ Score: _____
School: _____ Group No.: _____

Mission Possible:
Make the Town Bright!

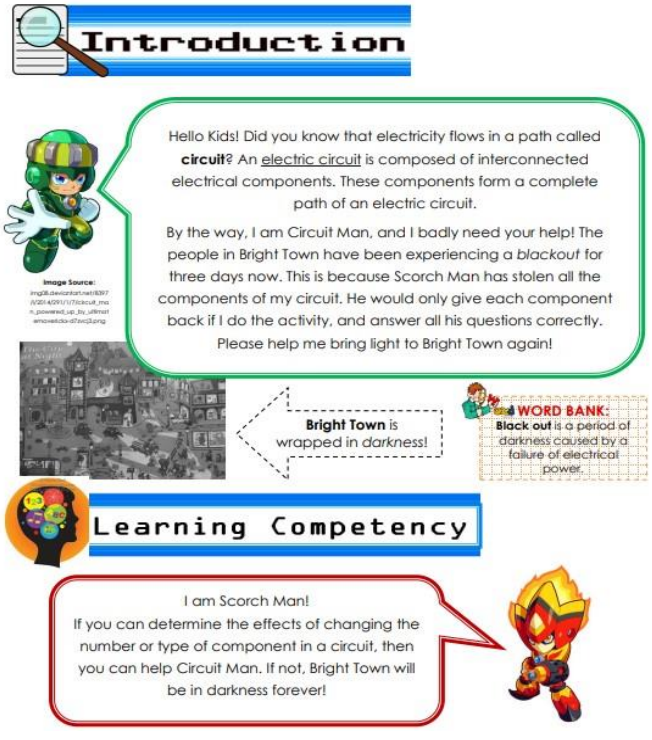
Directions:

1. Log on to your computer
2. Go to the following website: http://phet.colorado.edu/en/simulation/circuitconstruction-kit-dc
   Click the button that says "Play with sims…"
3. On the side bar under Simulations, select By Grade Level and pick Elementary School. Then, scroll down and click on the application that says Circuit Construction Kit (DC Only).
4. Click "Run now."

5. You now have the raw material to create a circuit. Take a moment to look over the site and find all the different materials. To build a circuit you will need several wires, a light bulb, a battery, a switch, and a resistor. Play with it to see how to grab and manipulate these tools.



6. Click the reset button.

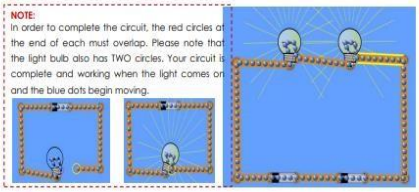


Procedure

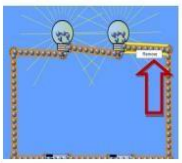
I. There are two types of circuits, the series circuit and parallel circuit. Using the Circuit Construction Kit, build a simple series circuit that consists of 10 pieces of wire, 2 light bulbs, and 2 batteries.

Your circuit may look like the image below.

NOTE:
In order to complete the circuit, the red circles at the end of each must overlap. Please note that the light bulb also has TWO circles. Your circuit is complete and working when the light comes on and the blue dots begin moving.



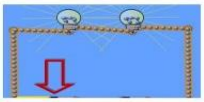
II. Now right click on one of the wires connected to a light bulb, and click remove.



Question A:
What did you observe?

Answer to Question A:

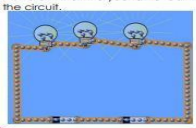
III. Return the wire you removed in II. Then, remove one of the wires touching the battery.



Question B:
What happened to the light bulbs and the blue dots in the circuit?

Answer to Question B:

IV. Return the wire you removed in III. Now, add a light bulb to the circuit.

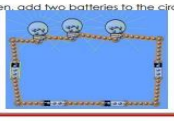


Question C:
What happened to the brightness of the light bulbs? How about the flow of the blue dots in the circuit?

NOTE:
To add a light bulb, right click on one of the wires connected to the bulb, then press **Split Junction**. Then grab a light bulb and wire to complete the circuit.

Answers to Question C:

V. Then, add two batteries to the circuit.



Question D:
What happened to the light bulbs? How about the flow of the blue dots in the circuit?

Answers to Question D:

VI. Raise your hand and let your teacher check your working series circuit.

Click the **Reset All** button to begin working on the next circuit. Parallel circuits provide more than one path for electrons to move. Create a parallel circuit in the Circuit Construction Kit, using 10 wires, 2 batteries and 2 light bulbs.

Your circuit may look like the image below.

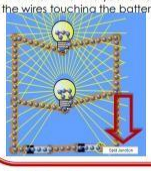
NOTE:
Your circuit is complete and working when the light comes on and the blue dots begin moving.

VII. Now, right click on one of the wires connected to a light bulb. Remove the wire.

Question E:
What did you observe?

Answers to Question E:

VIII. Return the wire you removed in VII. Then, remove one of the wires touching the battery.

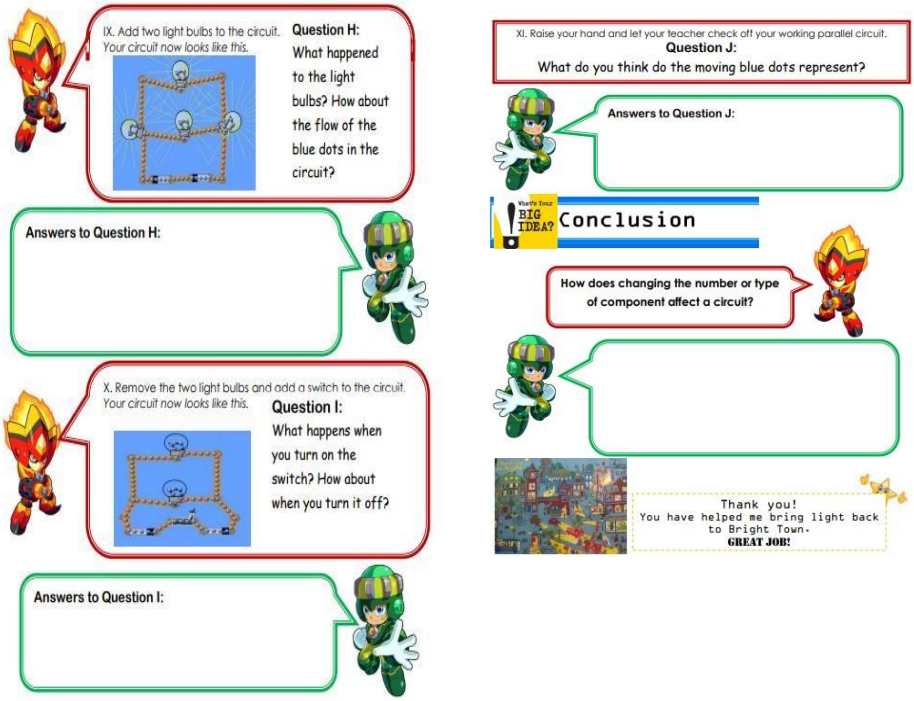


Question F:
What happened to the circuit?

Answers to Question F:

Question G:
What is the difference between removing the first wire and the second? Why is this significant?

Answers to Question G:



B. Final Version of Clash on Circuits Board Game (Research Instrument)