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Development of Card Game Flip It in Learning One Dimension Kinematics

Sotero O. Malayao Jr.[1*], Katrina Guila A. Peñafiel [2], Angel Rhea S. Caburnay [1], Joraidah B. Malaco [1] and Cristy Fernando Sardiñola[1]
[1]*Mindanao State University-Iligan Institute of Technology and Iligan, Philippines*
[2]*The National Teachers College and Manila, Philippines*

*Email: sotero.malayao@g.msuiit.edu.ph, 622000036@ntc.edu.ph, angelrhea.caburnay@g.msuiit.edu.ph, joraidah.malaco@.msuiit.edu.ph, cristyfernando.sardinola@g.msuiit.edu.ph

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Abstract. This study is an attempt to develop a supplementary material in teaching one-dimensional kinematics through card game. The study has dual purpose of lesson supplementation and as repeatable activity for review and as alternative material for class interruptions. Provisions were assured that the contents of the curriculum were targeted in the design of the game. It was evaluated 4.81 or very good in goals and objectives; 4.83 or very good in card design; 4.7 or very good in components and organization; 4.87 or very good in playability or playfulness; and 4.77 for usefulness with an overall average of 4.8. The mean normalized gain of the sample respondents is 0.46 or medium gain. The evaluation of experts and the normalized gain of the respondents point to the viability of the card game as promising intervention material in learning one-dimension kinematics. The use of the card game can be as instructional support, as supplementary material, as review material, and as pre-lesson activity. The study concludes that learning science can be engendered in a non-sequential form like what happened in this study.

Keywords: one-dimensional kinematics, material, game

INTRODUCTION

In many countries, the role and function of schools are changing, and so are the expectations of teachers. Teachers are being asked to teach in increasingly multicultural classrooms, to place a greater emphasis on integrating students with special learning needs, to make more effective use of information and communication technologies for teaching, to engage in more planning within evaluative and accountability frameworks, and to do better to make the learning environment as effective as possible

Physics is perceived to be a challenging subject. Physics, according to Oladejo et al., (2011), is one of the science subjects that students find difficult in school but Sheriff et al., (2011) said that physics is regarded as the most fundamental science subject, whose concepts and techniques help in the advancement of all other branches of science [2]. That's why physics is important because it contributes significantly to many of the inventions that shape modern life and has helped to explain many of the events that occur in everyday life. Physics is critical to the modern world's technological breakthrough. According to Erinosho (2013), physics is fundamental to comprehending the complexities of modern technology and is required for a nation's technological advancement [3]. Physics holds a delicate position in physical science (Shamim, Rashid, and Rashid 2014), which is why its teaching and learning must be taken seriously but doesn't have to be boring.

Incorporating games into education is frequently more effective than traditional teaching methods in increasing students' learning motivation, active participation, and concentration. Furthermore, Kirikkaya et al., (2010), said that games can improve students' social skills as well as their understanding and problem-solving abilities [4]. The search for creative ways to enhance the teaching and learning of science subjects, combined with the growing popularity of games, has led to increased study of Game-Based Learning (GBL) in the classroom. The use of games in the classroom has steadily increased as researchers and educators alike become more convinced of their high potential to facilitate the learning of science subjects (Morris et al., 2013) and promote positive changes in the school curriculum (Barton et al., 2018; Smith & Munro, 2009). Accorrding to Berland and Lee (2012) this methodology has also been shown to promote social development [5].

A game is a type of play in which participants must adhere to certain rules. (Houghton et al., 2013) defines educational games as the use of games to support in teaching and learning. Games can be used as a support tool to complement traditional teaching methods to improve the learning experience of the learners while also teaching other skills such as following rules, adaptation, problem solving, interaction, critical thinking skills, creativity, teamwork, and good sportsmanship. Learning should not be boring, and it should not be limited to rote memorization, in which students learn and grasp concepts through repetition or cramming. Teachers can use the energy and innovative thinking that technology in learning provides to improve student performance [6].

This study aims to provide a new strategy in learning physics subjects by making students actively involved in the classroom. Specifically, this study aims to enhance students' engagement in learning physics for better understanding and learning process in the class through a developed card game that focuses on One Dimensional Kinematics for Grade 12 STEM students.

RESEARCH OBJECTIVES

Physics has been challenging the students, and we can all agree that it is a difficult subject to pass. Most especially when there is no interesting and motivating factor to hype up the students to learn. Teachers are still sticking to the standard way of teaching. That being the case, the purpose of this research is to create a Card Game to enhance students' engagement in learning one dimension kinematics and to test its usefulness in the classroom.

The Development of Card Game Flip it in Teaching One Dimension Kinematics aims to:

1. Develop a Card game on One Dimension Kinematics
2. Evaluation of card game
   a. by the experts
   b. by the learners

3. Make trial Implementation
4. Investigate the performance of the learners
   a. difference in pretest and post test
   b. the normalized gain of the learners
5. Determine the perception of the students to the developed card game

NULL HYPOTHESIS

$H_{0:}$ there is no significant difference in pretest and post test scores

METHODOLOGY

This study uses quantitative and descriptive type of research. Quantitative and descriptive method would be used to evaluate the numerical results of the given assessment. This includes the rating of the science teachers towards the developed card game, the scores of the students during the pretest and posttest, the students rating in the evaluation, and the rating of the students towards the developed card game. And the perception of the students towards the card game. The science teachers evaluated the developed card game to determine its strengths and weaknesses.

Convenience Sampling was used in selecting the respondents of the study due to the availability of the respondents. The Learning Competency of the educational card game was based on the K to 12 Science Curriculum Guide.

Participants

Participants of the study is limited only to Grade 12 students in Iligan City, currently taking General Physics subjects this school year 2021-2022 and teachers from private and public school who are teaching General Physics subject in Iligan City. But because of the pandemic, limited face to class and modular distancing, it's hard for us to have grade 12 respondents, and the only available students that we could find are grade 10 students.

Research Tools

Researcher-Made Card Game - This will be used in implementation and game play setting.

Rating Scale - A 5-scale rating scale was adopted from the study of Gutierrez which is also about an educational card game. The rating scale has five categories: goals and objectives, card design, components and organization, playability and playfulness, and usefulness.

Achievement Test – A 20 item questionnaire for the pretest and posttest. The topic will be focused on One Dimension Kinematics. The questionnaire is a multiple-choice questionnaire.

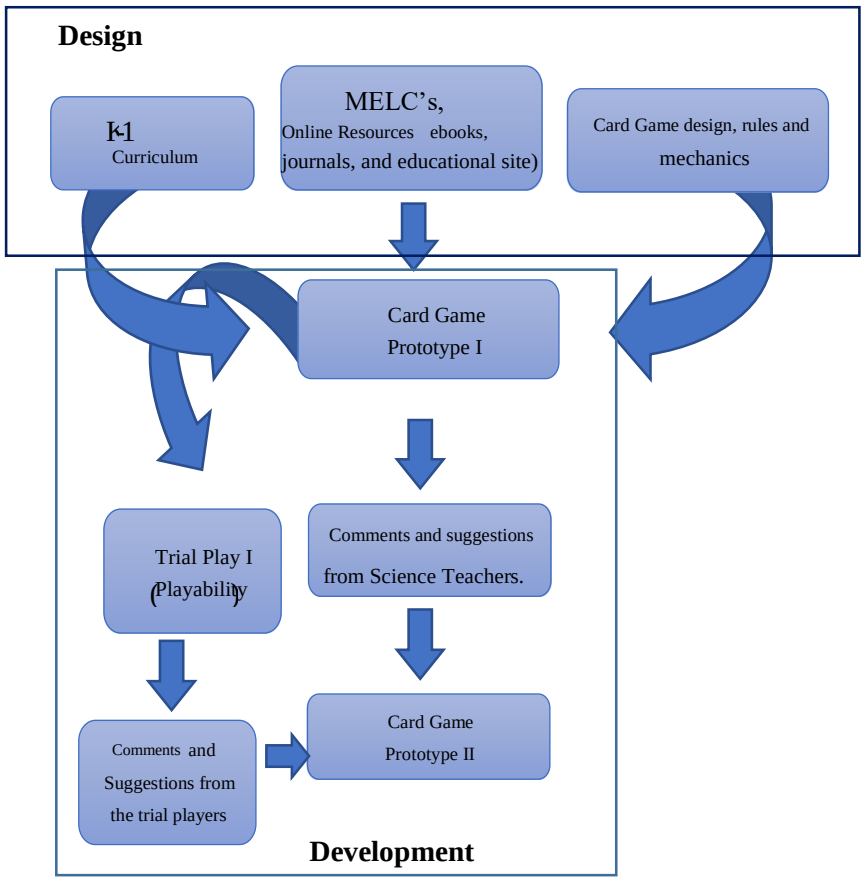
Task Evaluation - A questionnaire that was adapted and modified from Intrinsic Motivation Theory was used to know the students' perception and insights towards the tryout game. The questionnaire has four categories: interest/enjoyment, perceived competence, pressure/tension, and usefulness. This questionnaire is a seven-point scale questionnaire. The researcher modified the one part of the task evaluation, which is the usefulness category, so that it can fit in the card game activity.

K-12 Science Curriculum Guide - The science curriculum guide was used to serve as guide in choosing what and what nots question must be include in the developed card game.

Data Collection

Before conducting the study, the researchers chose a physics topic anchored with the curriculum guide that the students have a hard time learning.

PHASE I. Design and Development of the Card Game



Designing the Card Game

This card game is somewhat similar with Memory Game or Concentration Game. It is a popular card game played by the children and adults around the world. The questions used in the game was taken from the Science textbooks, K-12 Curriculum Guide, and some internet sources. The first design or element we put in the card is inspired by the standard deck of playing cards that consists of four (4) cards in each suit of Spade, Heart, Diamond, and Clubs, see figure 4. After the researcher presented the first design to the adviser, he wanted a unique element in our card game, and so the researchers changed the design into a PvS (plant vs zombie) theme cards, see figure 5. For the second design, it was suggested to come up with an original or own design as elements in the cards, the researchers came up with the third design, see figure 6.

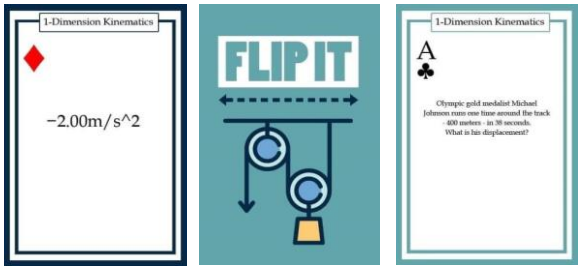


Figure 4 First Card Design

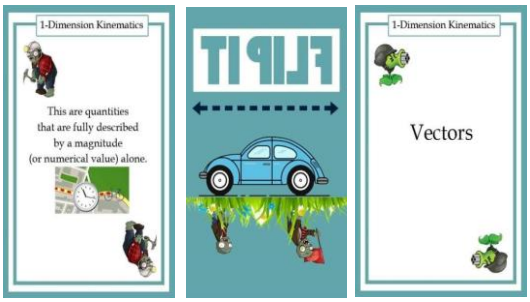


Figure 5 Second Card Design

Figure 6 Third Card Design

Developing the Card Game

Prototype I

The researchers sought the experts' (Science Teachers) opinion, comments, and suggestions of the prototype I of the card game using the Mean Rating Descriptor.

Table 2 is the Mean Rating Descriptors for the ratings of the experts.

4.21 – 5.0	Very Good
3.41 – 4.20	Good
2.61 – 3.40	Fair
1.81 – 2.60	Poor
1.0 – 1.80	Very Poor

Figure 7 Prototype I

Trial Play

A trial play was conducted by the researchers to determine its playability. The players during the trial play are the fourth-year college BSED-Physics student-teachers. As the game goes on, it can be seen that they are enjoying and learning at the same time because they were reminded of their past lesson. Also, they are having difficulty with reading the questions because the font size was too small for them. After getting the comments and suggestions, revision is done to enhance the playability of the game.

Table 3 is the Mean Rating Descriptors for the ratings of the trial players.

4.21 – 5.0	Very Good
3.41 – 4.20	Good
2.61 – 3.40	Fair
1.81 – 2.60	Poor
1.0 – 1.80	Very Poor

Prototype II

The comments and suggestions gathered from the trial play I helped the researchers to revise and enhance the card game.

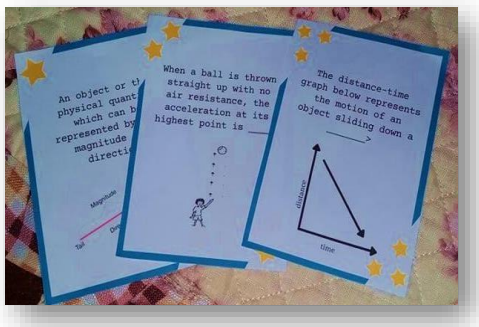
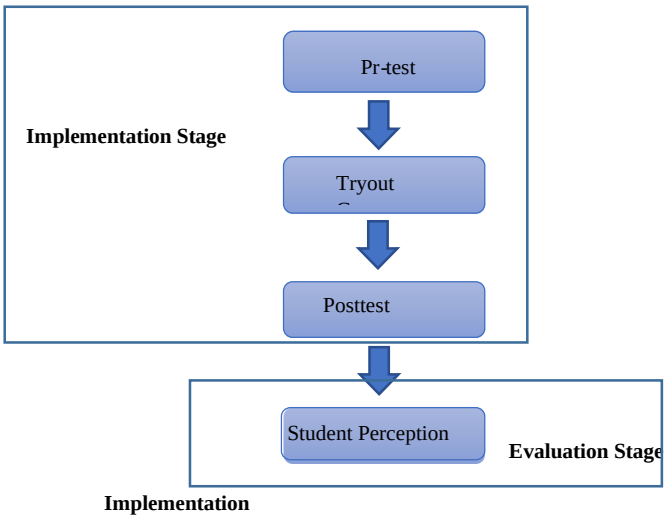


Figure 8. Prototype II

Phase II. Implementation and Evaluation of the Card Game



Pretest

A pretest was conducted to determine the student respondents' prior knowledge about One Dimension Kinematics.

Tryout Game

After the pretest, the tryout game follows using the prototype II cards. The game mechanics and procedure were introduced before the game started. The game continues until all cards have been matched and removed from the playing area.

Posttest

After the tryout game, the researchers conducted a posttest to see if there is a significant increase in the students' knowledge about One Dimension Kinematics after playing the tryout game.

Evaluation

Students' Perception

An evaluation sheet was given to the respondents to get or to determine their perception towards the tryout game or the activity.

Table 4. Mean rating for the Student's Perception

1.0 – 2.4	Not at All True
2.5 – 3.9	Somewhat True
4.0 – 5.4	True
5.5 – 7.0	Very True

Final Version

The researchers were able improve the design and made the final version of the card game base from the comments and suggestions gathered from the validation.

Data Analysis

Williams et al. stated that the main reason why students are not interested in learning physics is that they perceive physics to be a difficult/hard subject. Students find physics hard essentially because they have difficulties in solving physics problems. With that being said, the researchers developed a card game anchored in One Dimension Kinematics topic to add fun and interesting factor to the students' learning. The mechanics and design of the card game, materials to be used, and the respondents of the study was then decided to developed the card game. After the development of the card game, the researchers then acquired the evaluation, comments and suggestions from the science teachers in junior high school and senior high school, practice teachers (physics major), and respondents for further development of the card game.

All respondents were given a consent form as a written approval for their participation in the research. The main purpose of the form is to certify the respondents that their involvement in the said research is voluntary. The researcher informed the respondents about the objectives and purpose of the study.

The data gathered were coded. The science teachers coded as ST, hence, ST1 refers to the science teacher respondent number 1, and so on. The senior and junior high school students will be coded as S, hence, S1 refers to the student respondent number 1, and so on.

Table 5 Coding of Science Teachers

Respondents	Code
Science Teacher 1	ST1
Science Teacher 2	ST2

Table 6 Coding of Students

Respondents	Code
Student 1	S1
Student 2	S2

Statistical Method

Mean

Weighted mean was used to express the field experts 'evaluation of the developed educational card game. To interpret the ratings, the following descriptions were used: 1.00-1.80 (Very Poor); 1.81-2.60 (Poor); 2.61-3.40 (Fair); 3.41-4.20 (Good); and 4.21-5.00 (Very Good).

Normalized Gain

This was used to determine if there is a significant difference towards the perception of the students in using the card game.

$$< g >= \frac{(post\ test\ score - pre\ test\ score)}{(perfect\ score - pre\ test\ score)}$$

Table 7 Normalized gain

Normalize Gain Score	Interpretation
g<0.30	Low
0.31<g<0.70	Medium
0.71<g<1.00	High

RESULTS AND DISCUSSION

Design Stage

This card game is somewhat similar with Memory Game or Concentration Game. It is a popular card game played by the children and adults around the world. The questions used in the game was taken from the Science textbooks, K-12 Curriculum Guide, and some internet sources. Elements, such as stars are added to the cards that will also be the bases of the scores. This game will need 5-10 players. The cards composed of a 40-card deck with varying numbers and colors of stars. The red stars indicate the bonus questions. One yellow star indicates easy questions and equivalent to one point, two yellow stars indicates average questions and equivalent to two points.

Lastly, the three yellow stars indicate hard questions and equivalent to three points.

Development of the Card Game

After designing the card game, an evaluation form was given to the science teachers to rate the developed card game to determine its strengths and weaknesses.

Evaluation of the Educational Card Game by The Science Teachers

Table 8 presents the results from the evaluation. The evaluation was divided into five main categories the goals and objectives, the card design, the components and organization, the playability and playfulness, and the usefulness. It can be seen from the table below that teachers' find the goals and objectives, card design, components and organization, playability and playfulness, and usefulness as 'Very Good'. Furthermore, they also find the item 16 as 'Good'. Item 16 refers to the time duration in playing the game. Overall, the teachers rated the card game as 'Very Good'.

Table 8: Descriptive Evaluation of Teachers on the Developed Card Game			
	ITE MS	**Weighted Mean**	**Interpretation**
Goals and Objectives			
1	The purpose and rationale for the game are fully explained.	4.76	Very Good
2	The goals and objectives of the game are clearly defined.	4.88	Very Good

Table 8: Descriptive Evaluation of Teachers on the Developed Card Game			
	ITE MS	**Weighted Mean**	**Interpretation**
3	The game was thought provoking.	4.65	Very Good
4	The game encouraged student interaction.	5	Very Good
5	The game promoted discussion of key topics.	4.78	Very Good
6	The card game helps with my recall of concepts/terms.	4.80	Very Good
Average Mean		**4.81**	**Very Good**
Card Design			
7	Card size is appropriate.	4.77	Very Good
8	Having terms printed on all four sides of the card is a helpful feature for the players' handling of the cards.	4.80	Very Good
9	The picture printed on the card is representative of the topic.	4.70	Very Good
10	The material used (paper) in the preparation of the cards is durable.	4.88	Very Good
11	The deck of cards is compact and can be easily carried around.	5	Very Good
Average Mean		**4.83**	**Very Good**
Components and Organization			
12	The directions were clear, concise, and easily understood.	4.78	Very Good
13	The game emphasized key points of the topic played.	4.87	Very Good
14	The terms used were appropriate to my level of knowledge.	4.96	Very Good
15	The number of cards was appropriate.	4.87	Very Good
16	The length of time required to play the game is reasonable.	4	Good
Average Mean		**4.7**	**Very Good**
Playability and Playfulness			
17	The game provides opportunity for healthy competition and cooperation.	4.87	Very Good
18	The rules of the game provide players with equal conditions for a fair play.	4.87	Very Good

Table 8: Descriptive Evaluation of Teachers on the Developed Card Game			
	ITE MS	**Weighted Mean**	**Interpretation**
19	The rules of the game provide a set of options for flexibility in making decisions when playing the game.	4.8	Very Good
20	Playing the game was fun.	4.93	Very Good
Average Mean		**4.87**	**Very Good**
Usefulness			
21	The game was effective in reviewing	4.8	Very Good
	the material.		
22	The game encouraged the players to dig deeper into the subject matter.	4.53	Very Good
23	Playing the game is a productive use of time.	4.87	Very Good
24	Playing the game help me establish better relationships with the members of the group.	4.8	Very Good
25	I would recommend the game to my peers.	4.87	Very Good
Average Mean		**4.77**	**Very Good**
Overall Mean		**4.8**	**Very Good**
Legend: Very Good ~ 4.21-5.0 Good ~ 3.41-4.20 Fair ~ 2.61-3.40 Poor ~ 1.81-2.60 Very Poor ~ 1.0-1.80			

Thus, the developed card game was enhanced based on the comments and suggestions given by the science teachers. Here are some of the comments and suggestions of the science teachers.

ST5: Just make sure that the images and text will be visible in the cards

ST2: Classify your questions according to the level of your questioning (easy, average, difficult and bonus)

ST1: Shorten the sentences in the mechanics because there is a tendency that the student will no longer read it

ST3: Sand time is not accurate at all times. It is a very good supplementary learning materials for the learners.

Trial Play

The researchers conducted a trial play to determine its playability. The players during trial play are fourth year college Physics students. Here are the comments and suggestions during the trial play.

Comments

- *Engaging*
- *Makalingaw*
- *Dapat paspas mka huna-huna*
- *The font size of the card is too small*
- *Very helpful*

Suggestions

- *The timer should be digital*
- *Murag walay pulos ang dice, better not to have it and decide kinsa ang una before mag start ang game like bato-bato pick.*
- *Make the font size bigger*
- *Revised the questions that can be easily understood to the target participants*
- *Make the mechanics simple and easy to understand*

Based on the comments and suggestions gathered from the trial play, the researcher should create a bigger font and size of the card so that the game can be more visible. Also, the game mechanics and the sentence structures in the questions are enhance.

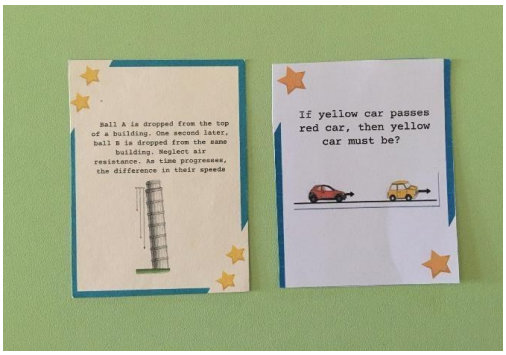


Figure 9 *Comparison of Card Game Prototype I and Prototype II*

Implementation Stage

The implementation of the developed card game started with a pretest to determine the prior knowledge of the students. It was then followed by the tryout game or the card game activity, where students played the game. After the tryout game, a posttest was given to the students to determine the level of learning they have acquired by playing the game. Lastly, a task evaluation was given to them to know their perception towards the card game activity. Twenty-three (23) grade 10 students played the try out game.

Performance of the Students towards the Try-out Game

The researcher conducts the try out game on the twenty-three Grade 10 students to determine the effectiveness of the developed card game. The researcher wanted to know the performance of the students in learning One Dimension Kinematics and if there is a significant difference between the normalized gain by each student.

Table 9 Performance of the Student Participants in Pretest and Posttest During the Tryout Game

Score	Pre-test		Post-test	
	Frequency	%	Frequency	%
1-5	14	60.87%	0	0
6-10	9	39.13%	8	34.78%
11-15	0	0	11	47.82%
16-20	0	0	4	17.39%
Total	23	100	23	100

Table 9 shows the performance of the student participants during the pre-test and post-test. As seen in the table, the pre-test results showed that 60.87% of the student participants had a score ranging from 1-5, 39.13% had a score ranging 6-10, and none of students' participants had a score ranging from 11-20. This implies that the students got the lowest scores in pre-test.

In the post-test results showed that 34.78% of the student participants had a score ranging from 6-10, 47.82%had a score ranging from 11-25, and 17.39% had a score ranging from 16-20, and none of the student participants had a score ranging 1-5. Base on the result after playing the game, most of the students had an increase in their scores.

Table 10 shows the scores gained by the students during pre-test and post-test. It also showed the individual normalized gain of the students during the try out game. In the study of Hake (1999), he categorized the normalized gain into three categories which are low g ($g < 0.3$), average g ($0.7 > g > 0.31$), and high g ($g > 0.71$) in measuring the increment of the students' performance after an intervention like an activity, lecture, etc. As seen in table 3, there are two (2) students or 8.70% of the total number of the participants belongs to the high g (normalized gain), fifth teen (15) or 65.22% of the participants belongs to average g, and there are six (6) or 26.09% of the participants belongs to low g. Those students who have a high g indicate that there is a substantial development of the students' performance during the post-test. Those who belong to average g have an intermediate development, and those who belong to low g have a moderate increase in their performance during post-test. This denotes that there is a significant increase in the performance of the students in learning One Dimension Kinematics after the try out game.

Table 10 Individual Normalized Gain of the Students

STUDENTS	PRE TEST SCORE	POST TEST SCORE	Individual Normalized Gain of the Students	Interpretation
S1	7	12	0.38	Medium
S2	3	9	0.18	Low
S3	3	12	0.59	Medium
S4	4	10	0.53	Medium
S5	5	14	0.60	Medium
S6	4	10	0.69	Medium
S7	7	13	0.46	Medium
S8	9	15	0.55	Medium
S9	3	10	0.41	Medium
S10	9	20	1	High
S11	5	11	0.4	Medium
S12	5	12	0.46	Medium
S13	9	14	0.45	Medium
S14	6	10	0.28	Low
S15	2	8	0.33	Medium
S16	10	17	0.30	Low
S17	3	13	0.59	Medium
S18	7	11	0.31	Medium
S19	5	16	0.27	Low

STUDENTS	PRE TEST SCORE	POST TEST SCORE	Individual Normalized Gain of the Students	Interpretation
S20	10	17	0.30	Low
S21	3	8	0.29	Low
S22	5	15	0.71	High
S23	3	13	0.59	Medium
Overall Mean	**5.52**	**12.61**	**0.46**	**Medium**

Evaluation Stage

Perception of the Students towards the Tryout Game

After the post-test, a task evaluation was given to the students to get their perception and insight towards the game. This questionnaire is a 7-point scale questionnaire. The activity task evaluation has four categories which are interest/enjoyment, perceived competence, pressure/tension, and usefulness.

Table 11 shows the perception of the students towards the try out game. In the interest/enjoyment category the students rated it mostly as a "Very True" except the 'I thought this was a boring activity' and 'This activity did not hold my attention at all', these two items in the interest/enjoyment category were rated as "Not at All True." This implies that the students enjoyed the game. In the perceived competence category only the 'This was an activity that I couldn't do very well' got a "Not at All True" rate and others were rated as "Very True" and "True." Based on the rating of the students in this category, it only implies that in playing the card game they can perform or do it well. In the pressure/tension category the students rated two items as "Very True" and the rest rated as "Not at all True." This category showed that students who were playing the game did not feel nervous and was very relaxed in doing the said activity. Lastly, in the usefulness category, the students rated it as "Very True" which implies that using the developed card game is helpful and useful for students.

Table 11 Perception of the Students Towards the Developed Card Game

Category	Scale							Mean	Interpretation
	1	2	3	4	5	6	7		
Interest/Enjoyment									
I enjoyed doing this activity very much					1	2	20	6.83	Very True
This activity was fun to do					1	19	3	6.18	Very True
I thought this was a boring activity.	4	15	2	2				2.09	Not True at all
This activity did not hold my attention at all.	12	11						1.48	Not at all True
I would describe this activity as very interesting.						5	18	6.78	Very True
I thought this activity was quite enjoyable.					4	10	9	6.23	Very True
While I was doing this activity, I was thinking					1	9	13	6.52	Very True

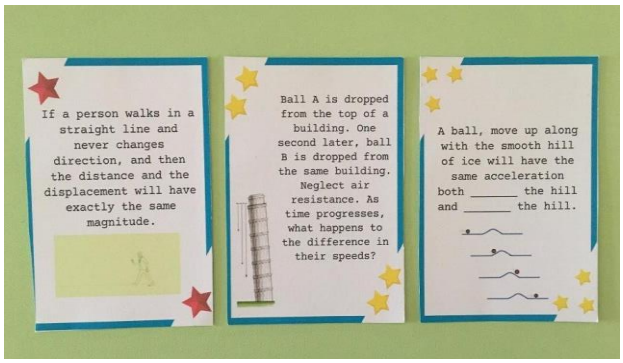
Category	Scale							Mean	Interpretation
	1	2	3	4	5	6	7		
about how much I enjoyed it.									
Perceived Competence									
I think I am pretty good at this activity					2	10	11	6.39	Very True
I think I did pretty well at this activity, compared to other students			1	7	5	8	2	5.13	True
After working at this activity for a while, I felt pretty competent.				2	2	5	14	4.22	True
I am satisfied with my performance at this task.				1	1	2	19	6.69	Very True
I was pretty skilled at this activity	1	1			5	12	4	5.51	Very True
This was an activity that I couldn't do very well	9	9	5					1.82	Not at all True
Pressure/Tension									
I did not feel nervous at all while doing this	1				3	7	12	6.7	Very True
I felt very tense while doing this activity.	19	3	1					1.22	Not at all True
I was very relaxed in doing these.						2	21	6.91	Very True
I was anxious while working on this task.	18	4	1					1.26	Not at All True
I felt pressured while doing these.	17	5		1				1.35	Not at All True
Usefulness									
I believe that doing this card game activity could be useful in understanding the concepts and terms of One Dimension Kinematics						1	22	6.96	Very True
This card game activity is important for a student like me.						3	19	6.56	Very True
This card game activity could improve my study habits.				1	2	10	10	6.26	Very True
I believe doing this card game activity could help me do better in school.					1	2	20	6.83	Very True
Legend: 5.5-7.0 ~ Very True, 4.0-5.4 ~ True, 2.5-3.9 ~ Somewhat True, 1.0-2.4 ~ Not at all True									

Here is the summary of the comments of the respondents:
S5: The game was very fun and enjoyable.
S7: It would be better if there are a greater number of groups playing the game.

S10: Challenging sya and at the same time knowledgeable.

Final Version

The researchers were able improve the design and made the final version of the card game base from the comments and suggestions gathered from the validation.



CONCLUSION AND RECOMMENDATIONS

Summary of the Findings

Based on the findings of this study are summarized and as follow:

1. The developed card game covered the concepts of One Dimension Kinematics. The overall rating of the developed card game was rated as “Very Good” by the science teachers.
2. The developed card game can be a supplemental material in understanding One Dimension Kinematics based from the comments and suggestions given by the science teachers.
3. There is a significant increase in the performance of the student participants during the pre-test and post-test which implies that there is an intermediate increase of their performance after an intervention.
4. The evaluation of the student participants to the developed card game in terms of goals and objectives, card design, components and organization, playability and playfulness, and usefulness was “very good”.
5. The motivation of the student participants after the try out activity showed a positive remark in terms of interest/enjoyment, perceived competence, pressure/tension, and usefulness.

Conclusions

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

1. The used of developed card game is a useful tool in learning One Dimension Kinematics. It is also enjoyable, challenging, engaging, interactive, interesting, and knowledgeable.
2. The utilization of game-based learning (GBL) in teaching and learning process can enhance, engage, and motivate students in learning a specific subject.

Recommendations

1. The study can be improved by utilizing the card on the target respondents which is for Grade 12 students.

2. The design, rules, mechanics and materials of the developed card game can be further enhance by laminating the cards, making use of card holder and by printing mechanics in a separate paper just like a guide.

3. Future studies may be conducted by other departments with a different science topic and other subjects.

4. Future researchers may modify the DepEd Module by utilizing the card game as a part of an activity in the DepEd Module.

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