

“Chipping the Genes”. Game-Based Learning Approach in Genetics-A Case of Monohybrid and Dihybrid Crosses and Interpretation

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Abstract

The main purpose of this study was to find out whether the use of a “**Chipping the Genes**”, a game-based learning approach in Genetics, would be effective in increasing the academic performance of Grade-8 students of Bai Saripinang National High School for the SY: 2019-2020.

This was an experimental research using the pretest and post-test design involving the five sections of Grade-8 Joy, Love, Charity, Chastity and Generosity. The respondents of the study were the students who did not reach the mastery level of the learning competencies in Genetics giving a total of 47 students. The respondents were given a 20-item teacher-made test as their pre-test and post-test. The statistical tools were employed using mean, standard deviation and t-test for independent samples.

Comparing the two groups, those who have undergone the use of educational board games as a learning approach in Genetics had a greater number of students whose performance belonged to Satisfactory and above than those who did not. Eighteen (18) or 59 percent are for those who were taught with Strategic Intervention materials while those who were not had 11 or 42 percent satisfactory and above.

Generally, these results implied that the use of a game-based learning approach in Genetics was effective in improving the academic performance of the Grade-8 students.

Key Words: Genetics, Game-based learning approach and Academic performance

Context and Rationale

Genetics helps explaining lots of things around us, like what makes you distinctive, why you look like other members of your family, why you are taller than the others and why some diseases run in your family, but learning genetics is often thought of as a subject or a topic in biology that is difficult to learn and understand, especially for novices. It has been observed that one common problem encountered by the students in the biological sciences is difficulty in understanding biological concepts.

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Due to the nature of the subject matter and the way learning processes occur and, possibly, the way it is being taught, the understanding of genetics ideas of the majority of students is thought to be very poor and full of confusion and alternative views (Chu, 2008). In the study of Longden (2010), he found the misconceptions and learning difficulties of the students were related to the nature of the concepts used in genetics.

Franklin (2003) noted that educational games have favourable characteristics for use in science education. One of the main ways to use games in science is to reinforce basic facts and principles. Psychologists such as Jean Piaget and Jerome Bruner, believe that play is a child's work. The effective way to teach pupils or students, they say, is through hands-on, active learning. That's where game-based learning comes in. Game-based learning refers to the borrowing of certain gaming principles and applying them to real-life settings to engage users (Trybus, 2015). With this approach, students are allowed to engage with educational materials in a playful and dynamic way.

Games make learning concepts more palatable for students and supply learners with a platform for their creative thoughts to bounce around. Effectiveness of an educational card game in reinforcing biological concepts in comparison with traditional teaching methods was found in the study of Gutierrez (2013). Educational games encourage creative behaviour and divergent thought and are excellent ice breakers (Fuszard, 2001).

Pho and Dinscore (2015) pointed out that game-based learning is not just creating games for students to play, it is designing learning activities that can incrementally introduce concepts, and guide users towards an end goal. Learning and play aren't at odds with each other, in fact, games are the vehicle and environment for learning.

In this study, researchers embarked on using "**Chipping the Genes**", a game-based learning approach in genetics for the concepts of monohybrid and dihybrid crosses and interpretation that will enrich learning of the Grade-8 students, thus attain growth in their academic performance.

Research Questions

The study investigated the effectiveness of "**Chipping the Genes**" in learning genetics of Grade-8 students enrolled in Bai Saripinang National High School, Bagumbayan, Sultan Kudarat during the School Year 2019-2020.

Specifically, it sought answers to the following questions:

1. What is the level of academic performance in Science of the Grade 8 students before the conduct of the study?
2. What is their academic performance in Science after the conduct of the study using the two strategies?
 - 2.1 Traditional Method (using Grade-8 Science Module)
 - 2.2 "**Chipping the Genes**" learning approach in Genetics
3. Is there a significant difference between the pre-test results of experimental and control groups?
4. Is there a significant difference between the post-test results of experimental and control groups?

Hypotheses

Sub-problems 1 and 2 were hypothesis free.

For sub-problem 3 and 4:

H_0 : There is no significant difference between the pre-test results of experimental and control groups.

H_0 : There is no significant difference between the post-test results of experimental and control groups.

Conceptual Framework

Innovation, Intervention and Strategy

This study used the “**Chipping the Genes**” learning approach in Genetics concepts of monohybrid and dihybrid crosses and interpretation. In this approach, the researchers employed the use of educational board games. The chips were used to solve monohybrid and dihybrid crosses in the Punnett Square.

The researchers referred to the revised Bloom’s Taxonomy established by Anderson and Krathwohl (2001) as the design standard for the educational board game.

- a. Remembering* – Factual knowledge: The students were asked to describe the terms used in genetics. E.g. genotype, phenotype, homozygous, heterozygous, dominant and recessive.
- b. Understanding* – Conceptual knowledge: The students explained the Law of Dominance, Law of Segregation and Law of Independent Assortment. In addition,
- c. Applying* – Meta-cognitive knowledge: The students used a Punnett square when solving for monohybrid and di-hybrid crosses with chips.
- d. Analyzing* – Procedural knowledge: The students will classify the expected genotype and phenotype of each cross.
- e. Evaluating* – Meta-cognitive knowledge: The students classified the Heterozygous (He) or Homozygous (Ho) genotype and solved for the phenotypic and genotypic ratios of any given cross and determined the expected phenotypic and genotypic ratio of each crosses.
- f. Creating* – The students choose their own alleles to cross and interpret the result.

This “**Chipping the Genes**” learning approach in Genetics serves as a tool in improving the instructional methods and strategy of teachers and makes science an interesting and enjoyable subject, so that students are motivated in understanding science concepts and principles thereby increasing their academic performance.

Literature Review

Game-based Learning Approach

A study from Vanderbilt University demonstrates the impact of rigorous, peer reviewed research into curricular tools, in this case showing that students who played educational games out performed their peers on standardized tests (Polikov, 2017). According to Bruner as stated by Nott (2016), students who engage

in hands-on learning and play-based activities experience the following benefits; increased motivation, buoyed creativity, enhanced problem-solving skills, a greater sense of personal responsibility and the joy of autonomy and independence. A card game has been developed and used to teach nomenclature of the elements and their symbols in the first laboratory session of General Chemistry. The game both helps the students learn or review the symbols of the elements (Granath and Russell, 1999).

In a classroom situation, teacher-student interactions and student-student interactions exert a profound impact on learning. Unlike interactions in digital games via computers, face-to-face interaction exposes people to human expressions, physical action, and verbal tones (Billinghurst & Kato, 2002).

Thus, using educational card games as a medium for game-based learning could enhance the direct interpersonal interaction between teachers and students as well as among students to a degree unmatched by the sound and audio effects of digital games. This study designed a science lesson using an educational card game. By handling the cards and moving the character pieces themselves and competing or cooperating with peers through direct verbal communication, students can interact with one another and learn happily from within.

Academic Performance

It is currently understood that, in order for students to be considered “fully proficient in science”, they must be able to (1) know, use, and interpret scientific explanations; (2) generate and evaluate scientific evidence and explanations; (3) understand the nature and development of scientific knowledge; and (4) participate productively in scientific practices and discourse (Duschl et al., 2007). There is a growing understanding of the role that early childhood education can play in building science literacy. Infinitely curious about the world around them, children constantly observe and explore, take in new information, and generate their own ideas about how the world works. It is now widely known that cognitive stimulation in the early years is critical for brain development and that young children have cognitive capacities far beyond what was previously believed (Shonkoff & Phillips, 2000).

Most students perceive science as very difficult, heavily content loaded, very dull and demanding passive reception rather than active involvement with the learning process (Woolnough, 1994).

With the above-mentioned problems, the teacher cannot expect much from the students in terms of the application of concepts. This may even be the reason for obtaining low scores in science examinations, as in the case of the Third International Mathematics and Science Study (TIMSS) examination where the Philippines ranked 36th in the Science test among the thirty-eight participating countries (Tan, 1999). Laviña (2000) emphasized that “the dismal result of the Third International Mathematics and Science Study (TIMSS) was a much-needed wake up call for the country”.

The achievement scores, whether in local or international examinations, are means to measure comprehension on different subject areas and highlight students’ overall academic performance. The National Achievement Test (NAT) results for Year 4 MPS by Learning Area of SY 2012-2013 and SY 2013-2014 showed Science with 42.90 and 46.43 respectively. In the division level, the Sultan Kudarat acquired a mean percentage score of Science Year 4 of 45.87 which belonged to below average. This MPS was second to the lowest in Region XII for the SY 2013-2014. As stated in the annual report of the Region XII-SOCCSKSARGEN,

sixty seven percent or 387 out of 579 secondary schools belong to quartile 3 in Year 4 science performances, which means that more than half of the total number of secondary schools obtained below average scores. Thus, the region needs to employ strategies that would improve the 28 or 5% secondary schools belonging to quartile 4.

Analysis of the test and the results Condes-Tandong showed that the Filipino students have difficulty for the following reasons: 1) they have not mastered the concepts needed to answer the items; (2) they do not understand the problem; and (3) the content related to some items is not formally taken up in the curriculum (Tandong, 2000). This implies that students do not master the concepts and lack conceptual understanding regarding the topics already covered. Enough content is covered but not much learning takes place. It is for this reason why the teaching of science must be student-centered and equipped with a variety of instructional learning strategies.

Based on the K to 12 curriculum, science subjects are learner-centered and inquiry-based, emphasizing the use of evidence in constructing explanations. Concepts and skills in Life Sciences, Physics, Chemistry, and Earth Sciences are presented with increasing levels of complexity from one grade level to another (spiral progression), thus paving the way to deeper understanding of a few concepts but there are competencies which are not mastered by the pupils and students.

In its continuing effort to raise the quality of education in the country, the Department of Education (DepEd) continuously implements innovations particularly in Science. The focus of the Science Education Program of the Basic Education Curriculum is to make learning meaningful for students, in order to improve their achievement. In fact, most of the seminars, training and scholarships sponsored by the DepEd and Department of Science and Technology (DOST) for teachers teaching science subjects have the objectives of furthering the enhancement of their knowledge and skills in delivering goods to the students.

Moreover, Shaffer (2012), added that there is a need for instructional materials to foster the active mental participation of students in the learning process. The development of a curriculum that fulfills this need should be guided by knowledge of what students know and can do, rather than by assumption about what they should be able to do.

The materials and teaching aid of the plan should provide a checklist of everything except the use to teach the lesson. In short, anything that the learner does not have you must supply (Alcantara, 2011).

In meaningful deliberation of the lesson in a teaching-learning situation, materials are used as aid to facilitate learning. Materials like cards, workbooks, modules, visual aids, pictures, graphs and flipchart greatly help the teachers and students for a meaningful outcome.

Research Methodology

Research Design

The randomized pretest-posttest control group design was employed in this study which is an experimental method of research. According to Fraenkel, Wallen, & Hyun (2012) this is a design to investigate possible cause-and-effect relationships by exposing one or more experimental groups to one or more treatment conditions and comparing the results to one or more control groups not receiving the treatment, random

assignment being essential. Two groups of subjects are used, with both groups being measured or observed twice and the first measurement serves as the pretest, the second as the posttest.

Locale of the Study

The study was conducted at Bai Saripinang National High School located at Purok Magsaysay, Bai Saripinang, Bagumbayan, Sultan Kudarat.

Respondents

The respondents of the study were the students from the (5) sections of the Grade-8 for the SY: 2019-2020. A simple random sampling was employed and Group 1 became the experimental group and Group 2 assigned as the control group.

Data Gathering Instrument

The following were the research instruments used in the study.

1. “Chipping the Genes”. A game-based learning approach in Genetics

In designing this educational board game of this study, the researchers referred to the seven design principles proposed by Liu (2011): Analyze the traits of the learners and understand their prior knowledge; establish clear teaching objectives and select appropriate gaming equipment, combine the teaching objectives with the game content; remember that teaching is the primary goal and that the game is a supplementary tool; take advantage of game characteristics to arouse student interest; enable students to enjoy learning while they take control of learning; and periodically assess learning effectiveness and improve teaching.

These educational boards underwent conceptualization and planning. For the game development, this includes designing and pre-implementation of the educational board game. For this study, the researchers selected two main topics in genetics, the monohybrid and dihybrid crosses and interpretation.

After the initial development process completed and before the actual use of the game, science teachers were asked to review and validate the educational board game based on its goals and objectives, design, components and organization, playability and playfulness, and usefulness.

2. Pre-test/ Post-test

It is a 20-items teacher-made test designed to measure the mastery level of the students on the lessons chosen by the researcher. The items in the test are analyzed and validated. The assessments were given to the participants before and after the learning activity, with the problems from the pre-test reordered in the post-test to reduce the effects of repeated exercise.

Data Gathering Procedure

A pilot pre-test was done before the experiments using the validated test items. The experimental group was exposed to the use of “**Chipping the Genes**” while the control group was exposed to the traditional way of teaching using the Grade-8 Module in Science. A pre-test was given to both groups before the introduction of the lesson and a post-test after the end of the lesson. The same pre-tests and post-tests were given to the experimental and control group.

Furthermore, the control group were given the same lessons, same number of contact time and rules with the experimental group. They will only differ in the instructional materials used. Their scores in every treatment were tallied and interpreted by the researcher to determine whether there were significant differences on their mean scores in the pre-tests and post-tests.

Data Analysis Plan

The following are the statistical treatment to be used in the study:

1. Mean and Mean Percentage
2. Standard deviation
3. t-test formula for independent samples

Results and Discussion

Academic Performance in Genetics of both Experimental And Control Groups

Table 1 Academic Performance Level in Science Before the Conduct of the Study

PRE-TEST RESULT					
Academic Performance Descriptors	Scores	Frequency		Percentage	
		Experimental Group	Control Group	Experimental Group	Control Group
Above Satisfactory	15 and above	0	0	0%	0%
Satisfactory	8-14	4	5	13%	17%
Below Satisfactory	1-7	26	25	87%	83%
Total		30	30	100%	100%

The table above shows the pre-test results of the two groups. Frequency counts and percentage were employed to treat the data gathered. Majority of the respondents were found below satisfactory level of academic performance for both experimental and control groups with 26 and 26 students or 87% and 83% respectively. They were students who scored between 1-7 out of 20-item test. A total of 4 students had satisfactory level of performance in the experimental group and 5 students in the control group were also in the same level. No one had an above satisfactory level of performance in both groups.

Table 2 presents the data about the academic performance in science after the conduct of the study among the control group. It was revealed in the data that the majority of the students in the experimental group reached a satisfactory level of performance after the use of “Chipping the Genes” with a total of 17 students or 57%. Eleven (11) students or 37% of the students in the experimental group had an above satisfactory level of performance and only 2 students found below satisfactory level.

Table 2 Academic Performance Level in Science After the Conduct of the Study

POST-TEST RESULT					
Academic Performance Descriptors	Scores	Frequency		Percentage	
		Experimental Group	Control Group	Experimental Group	Control Group
Above Satisfactory	15 and above	11	2	37%	7%
Satisfactory	8-14	17	12	57%	40%
Below Satisfactory	1-7	2	16	6%	53%
Total		30	30	100%	100%

Further results show that there were 16 or 53% found to belong below Satisfactory level of performance in the control group. Fifteen (15) or 40% of the students without game-based learning approach found to be in satisfactory level and only 2 students reach the highest level of performance in the control group.

Effectiveness of the “Chipping the Genes” as learning approach in Genetics

To arrive at an answer about the sub-problem no. 3, t-test for independent samples was employed.

Table 3.1 Test for Significant Difference Between Pre-Test Results of Experimental and Control Groups

Groups	N	Mean	SD	Sig.	df	t	Interpretation	Decision
Experimental	30	6.07	1.98	.468	58	.632	Not Significant	Accept the Null Hypothesis
Control	30	5.73	2.10					

Table 3.1 shows that the Mean (x) The value obtained of the experimental group was 6.07 with SD 1.98, while the control group was 5.7 with SD 2.10, giving a difference of .34 in their means in favor of the experimental group. The results indicate that the pre-test scores of the both groups had no significant difference ($t=.632$, $p>0.05$) as shown in the table above which led to the acceptance of the null hypothesis.

Table 3.2 Test for Significant Difference Between Post-Test Results of Experimental and Control Groups

Groups	N	Mean	SD	Sig.	df	t	Interpretation	Decision
Experimental	30	12.03	2.14	.000	58	6.38	Significant	Reject the Null Hypothesis
Control	30	8.77	1.81					

Table 3.2 presents the data about the difference between the post-test scores of both groups. Experimental group has a mean of 12.03 which is greater than the mean of the control group which is 8.77 giving a difference of 3.26.

Data further reveal that the test for their difference is significant with ($t=-6.38$; $p<0.05$) which leads to reject the null hypothesis. The results indicate that the academic performance in Genetics of the two groups differ in favor of the experimental group. It meant that those students who had undergone learning the concepts of Genetics with the use of “**Chipping the Genes**” learning approach in Genetics performed better than those students taught in traditional way of teaching.

Reflection, Conclusions and Recommendations

After the conduct of the study, both methods (traditional or using the “**Chipping the Genes**”) were found to be effective methods of enhancing understanding of genetics concepts. However, students who used the “**Chipping the Genes**” had a significantly higher gain in scores than students who were exposed to the traditional methods. Thus, it has been discovered that the use of a student-centered approach like “**Chipping the Genes**” can improve student performance to a greater extent than traditional methods.

Based on the results of the study, it is concluded that:

1. Majority of the respondents were found below satisfactory levels of academic performance for both experimental and control groups.
2. Majority of the students in the experimental group who used the “**Chipping the Genes**” reached the above satisfactory levels of performance compared to the control group.
3. Before the conduct of the study, no significant difference was found between the test results of the experimental and control groups.
4. A significant difference was found between the post-test results of experimental and control groups.

In the light of the results gathered, it is recommended that:

1. The use of “**Chipping the Genes**” should be continuously observed in teaching the concepts of Genetics. If possible, additional instructional materials should be constructed and utilized in teaching Genetics.
2. School administrators and parents should support the needs of the teachers in producing more supplementary materials appropriate to the content of the subject matter to be taught. They should assist the teachers to produce desirable and interesting materials in teaching Science.
3. Students who lag behind, especially those found to be poor in their academic performance in Genetics under the control group should be given preferential attention through the conduct of remedial teaching of the subject.
4. Similar studies focused on production and validation of “**Chipping the Genes**” are recommended to be conducted in the future and if possible it is suggested to utilize other learning areas.

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