Group Guided Discovery Approach cum Gamification: Mastery of translations from Algebraic expression into statements and vice versa

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Abstract: **The general purpose of this study was to determine the mastery of students' Translations from Algebraic expressions into Statements and vice versa through blended interventions which were the Group Guided Discovery Approach and Gamification (Algebra Bingo and Quiz Bowl). The study adopted the quasi-experimental approach with one group Post-test only design in Grade 7-section Orchid at Naval State University- Laboratory High School (NSU-LHS). The students' Post-test mean percentages in translating Statements into Algebraic expressions and vice versa increased while the mean error decreased. There is a significant difference between students' Pre-test and Post-test scores and students' errors in Translating Statements into Algebraic expressions and vice versa.**

The students agreed that the use of Group Guided Discovery Approach and Gamification was effective in translating Algebraic expression into Statement and vice versa with an average weighted mean of 4.29 and 4.46 respectively. Positive results were also derived from the Analysis of Feedback Evaluation sheet and reinforced qualitatively from the Interview through Focus Group Discussion.

Keywords: **Group Guided Discovery Approach, Gamification, Mastery of translations, Algebra Bingo.**

I. INTRODUCTION

In a real life context, problem solving skill is an essential part for human survival (Tambychika & Meerah, 2010). Thus, needs to be acquired and to be enhanced for every students. Mathematics is an integral part of humans' life for it pervades life at all. However, there were many recent researches worldwide found out the overarching students' difficulty towards problem solving. These following researchers: (Garderen, 2006)**,** (Kadir, Bejor, Nathiman , Moamed , & Khamis , 2003), (Tambychik, 2005) & (Ismail, Di Mana Susahnya Matematik, 1997) claimed that from among the disciplines of mathematics students struggle most in problem solving, because of its direct application of various needed skills. Indeed, (Desa, 2004) & (Berch, 2007) emphasize that most students did not equipped the necessary basic skills in mathematics. As a result, it leads to various errors and confusions in the process of problem solving.

Moreover, one of the necessary basic skills that students need to acquire is the skill to translate statement into algebraic expression and vice versa for the successful problem solving. As emphasize by (Ismail, 1997), there were two main procedural steps in problem solving: 1. Transformation of the problem into mathematical expression or equation either 2.And computation of the created equation. According to (Nathan V., 2002) & (Garnett, 1998), they highlighted one of the leading mathematical concepts that resulted students' difficulties were the following: transformation of information mathematically, mastery of mathematical terms, and understanding mathematical language. Therefore, the success of problem solving is highly dependent on the translations from Algebraic expressions into Statements and vice versa which has been the primary focus of this study.

In Philippine context of mathematics K to 12 curriculum guide, specifically in Grade 7, translations from Algebraic expressions into Statements and vice versa holds an essential role for the success of performance task which is able " to model situations using oral, written, graphical, and algebraic methods in solving problems involving algebraic expressions, linear equations, and inequalities in one variable". The focus of this study is the first of its line in Pattern and Algebra, thus other topic such as linear equation and inequalities dependently rely on the success of students' translations.

The researchers had already administered Pre-test on Grade 7 section Orchid in Naval State University-Laboratory High School and undergone a thorough analysis of identifying students' level of performance and even specific students' errors. The said analysis was presented in tables and figures with clear results discussion that leads for the researchers to conduct study pertaining to translations from Algebraic expressions into Statements and vice versa. Furthermore, to address the overarching problem of the selected students from Grade 7, the researchers proposed a blended interventions namely; Group Guided Discovery approach in which it is also a hands-on approach that addresses mastery of learning towards translations, specifically the mastery of rules that bounds for every activity and Gamification which is one way for supporting students' prior knowledge.

It has been always said, that students' learned best if they are the one who explore ideas and concepts. Just like scientists, students are the one who discover and solve problems. Group Guided Discovery approach has been reported as effective tool towards students learning. According to (Castronova), Group Guided Discovery approach is an active learning where it help students to enhance skills that are highly useful for other higher major concepts. Gamification on the other hand, is a use of game design that contextualize a certain topic for students' enhancement of students learning (Graziela de Souza Sombrio1 V. R., 2014). It has been reported by Gartner, that the use of gamification motivates people and achieve desired goals.

The purpose of conducting this study was to determine the mastery of students' Translations from Algebraic expressions into Statements and vice versa through blended interventions which were the Group Guided Discovery Approach and Gamification.

STATEMENT OF PURPOSE

The general purpose of this action research was to determine the mastery of students' Translations from Algebraic expressions into Statements and vice versa through blended interventions which were the Group Guided Discovery Approach and Gamification.

Thus, specifically answers the following questions:

1. What is the Mastery Level of the students before and after the use of Group Guided Discovery Approach cum Gamification in terms of the following?

1.1 Translating Statement into Algebraic expression and vice versa

2. What is the Mastery Level of the students before and after the use of Group Guided Discovery Approach cum Gamification in Translating Statement into Algebraic expression in terms of the following?

1.1 Processual

1.2 Granular

1.3 Objectified

3. Is there a significant difference between students' Pre-test and Post-test scores in Translating Statements into Algebraic expressions and vice versa?

4. Is there a significant difference between students' Pre-test and Post-test scores in terms of students' errors in Translating Statements into Algebraic expressions and vice versa?

5. What are the feedback of the students on their experiences about the lesson involving Translations of Algebraic expressions and Statements using the Group Guided Discovery Approach cum Gamification.

DEFINITION OF TERMS

Group Guided Discovery Approach. Is a hands-on approach that emphasizes on students' contributions to their own learning by means of teacher's posing question and assistance as well. Students' are no longer passive participant but

rather active on the sense that they will be discovering the rules and concepts. Afterwards, they will be generalizing the topic and it creates impact on students' learning and retention as well.

Gamification. Is a culture of games that is being derive or innovate with accordance to the context of specific topic and has been crafted to enhance students' learning.

Mastery. It is students' achievement that ranges from high and very high in terms of students level of performance.

Translation. Is a process of changing one situation into a new form.

Algebraic expression. It is written in an Algebraic language that contains numerals (e.g. 1, 2, 3, 4, 5…), symbols (e.g. +,-, /, x, =,>, <) and variables (e.g. x, y, z)

Algebraic statement. It is an Algebraic expression that is written in English phrase.

Framework of the study

Theoretical. The theories cited below provides foundation and used to gear for the process of the current study.

Jean Piaget's Constructivism theory. The aim of this theory is to explain the mechanisms and the processes by which a child develops into individual who can reason and can think using hypotheses wherein a certain child learned through by doing and it is a way to have an active exploring- was seen as central to the transformation of school curriculum.

According to Piaget (1958) assimilation and accommodation is one of the primary process where it encourages learners to be active not a passive one. Assimilation causes individual to incorporate new experiences into the old experiences. Accommodation on the other hand, is reframing the world and new experiences into the mental capacity already present. This theory argues that people produce knowledge and form meaning based upon their experiences.

Piaget's theory of Constructivism addresses how learning actually occurs, not focusing on what influences learning.

David Kolb's Experiential learning theory. This theory exposed its principle that people learned best through discovery and experience. The work of Kolb is taken from the proponent people namely: Lewin, Piaget, Dewey, Freire and James, forming a unique perspective on learning and development. The central role of this theory is the experience plays in the learning process.

The Experiential learning theory follows a learning cycle and the following are:

1. Concrete experience. This is the first stage of Kolb's theory in which it emphasizes the active involvement of the learners. This model stressed out that one cannot learn by only watching or reading the concept, hence it adheres the effectiveness of learning by doing among team, peer, or individual.

2. Reflective observation. This is a second stage in which it means taking time-out from "doing" and reviewing what has been done and experienced. At this stage lots of questions are asked and communication channels are opened to others members of the team.

3. Abstract conceptualization. It is a process of interpreting the events and understanding the relationship between them. At this stage learners makes a comparisons between what they had already done and contemplating what they already know.

4. Active experimentation. Active experimentation is the last stage, where learners take a consideration of how they are going to utilize what they have learned. This emphasizes planning enables acquired learning translates into a newly constructed idea from the current knowledge.

ARCS Model. This is a model for gamification that is use for creating e-learning and courseware. ARCS is a mnemonic aid for Attention, Relevance, Confidence and Satisfaction.

The following are the specific explanation of the mnemonic aid.

1. Attention. –Perceptual, inquiry, variability

2. Relevance –Goal orientation, match motives, familiarity, modelling

3. Confidence –Clearly state the learning requirements and expectations in the beginning; Small opportunities for success; Different and challenging experiences that build upon one another.

4. Satisfaction–Opportunity to apply new knowledge and skills; Positive encouragement and reinforcement.
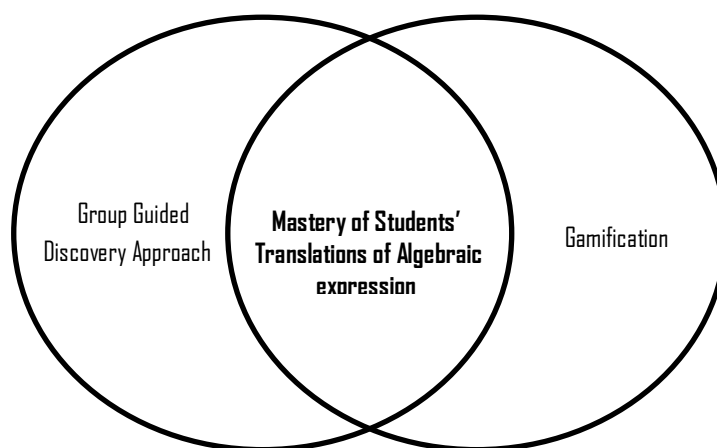
Figure 1: Paradigm of the study

II.   RESEARCH METHODOLOGY

This chapter shows the research design, the research respondents, research locale research instruments, data gathering procedure, statistical tools for the analysis of data gathered.

Research Design

The design of this study adopted a Quasi-Experimental design specifically "One group Post-test only design" where Pre-test observations were made on a single group. The group receives a treatment of some type and Post-test observations was made. Quasi-experiments are studies that aim to evaluate interventions that do not use randomization (Harris A. D., 2006). Therefore, the chosen design strongly fits on the current study due to a reason that Pre-test observations were already obtained.

Research Locale and Respondents

The researchers had selected students from Grade 7 section Orchid for the study with 47 participants at Naval State University- Laboratory High School, located at P. Innocentes St. Naval, Biliran.

Research Instruments

To answer the purpose of this study, the researchers conducted a Post-test that was parallel to the Pre-administered test that had undergone a dry-run to test instrument's validity.

The dry run was conducted on the other section at Naval State University-Laboratory High School Grade-7 Dahlia.

 The researchers prepared a Descriptive survey-questionnaire consulted by an expert and a researcher- made interview questionnaire parallel to the researcher-made for their feedbacks regarding on the proposed blended interventions to qualitatively validate and gain broad range of views on the result of the feedback evaluation.

Data Gathering Procedures

The researchers send a letter of permission for the principal as well as for the math teacher allowing us to conduct a study. The researchers had already conducted a Pre-test regarding on students' translations of Algebraic expression and statements and deliberately analysed the data, due to the poor performance of students' translation from Algebraic statement into expression and moderate performance on students' translation from Algebraic expression into statement, the researchers decided to address the problem and finally implemented Group Guided Discovery Approach cum Gamification.

The implementation of the interventions took 4 days. The first day was implementation of motivational activity followed by an exploration about the translations of Algebraic expression and Statement through Group Guided Discovery Approach. The second day was the continuation of the activity, selected students presented what they'd discovered. The students who were chosen to present was picked by means of lottery method. After all the presentations, a short discussion by the assigned researcher assimilated what all students discovered and expound it as well. The third day, was

the enhancement of students' learning through Gamification. Students in specific played "Algebra Bingo" adopted from the Filipino recreational activity which is the "Bingo game" and "Quiz bowl".

The fourth day was the evaluation, the researchers had conducted a Post-test parallel to the Pre-administered test that undergone dry-run test. The sources of items was randomly chosen based from the current and the last year's book of Grade 7 in NSU-LHS. After the administration of the test, a researcher-made Descriptive survey-questionnaire was disseminated that had undergone an expert consultation to avoid inaccuracy of its content. Afterwards, a follow up interview using focus group discussion was utilized in order to qualitatively validate and gain broad range of views on the result of the feedback evaluation. The questions from the interview was parallel to the survey questionnaire.

III. RESULTS AND DISCUSSION

This section was gathered from the research instrument. The students' outputs were scored and analysed to determine the mastery of students' Translations from Algebraic expression into Statements and vice versa through blended interventions which were the Group Guided Discovery Approach.

The data collected were presented in tables, figure and they were group based on the order under this study. The results of Pre-test, Post-test, survey, and focus group discussion were interpreted. This followed by the significant difference between students' Pre-test and Post-test scores and the significant difference between students' errors in Translating Statement and Algebraic expression and vice versa.

Table 1: Mean Percentage and Mastery Level
(Translating Statement into Algebraic Expression)

Translating Statement into Algebraic expression				
Pre-test			**Post-test**	
Score	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
15	0	0	1	2.2
14	0	0	4	8.5
13	0	0	7	14.9
12	0	0	12	26.6
11	0	0	10	21.3
10	1	2.2	3	6.4
9	0	0	3	6.4
8	2	4.3	3	6.4
7	1	2.2	2	4.3
6	6	12.7	2	4.3
5	9	19.1	0	0
4	2	4.3	0	0
3	4	8.5	0	0
2	10	21.3	0	0
1	11	23.4	0	0
0	1	2.2	0	0
Total:	**47**	**100**	**47**	**100**
Mean Percentage:	**24.67%**		**75.33%**	
Mastery Level:	**Very Low Mastery**		**Moving Towards Mastery**	

Table 1 showed an improvement of students' translation in statement into Algebraic expression. Collectively, the students' mean percentage in the Pre-test increased up to 50.66 percent having 75.33 percent during the administration of the Post-test and their mastery level were very low and moving towards mastery respectively. This indicates the effectiveness of the implemented interventions.

Table 2: Mean Percentage and Mastery Level
(Translating Algebraic Expression into Statement)

Translating Algebraic expression into Statement				
Pre-test			Post-test	
Score	Frequency	Percentage (%)	Frequency	Percentage (%)
5	15	10.64	28	59.6
4	14	29.78	10	21.3
3	7	14.2	7	14.9
2	8	17.02	2	4.3
1	9	19.14	0	0
0	4	8.5	0	0
Total:	**47**	**100**	**47**	**100**
Mean Percentage:	**54%**		**86%**	
Mastery Level:	**Average Mastery**		**Closely Approximating Mastery**	

As shown in table 2 there is an improvement of students' translation in Algebraic expression into Statement. Collectively the students' mean percentage in the Pre-test increased up to 32 percent having 86 percent during the administration of the Post-test and their mastery level were Average Mastery and Closely Approximating Mastery respectively. This indicates the effectiveness of the implemented interventions.

Table 3: Mean Percentage and Mastery Level of Algebraic Discourse
(Processual, Granular, Objectified)

Processual			Granular		Objectified	
Pre-test		Post-test	Pre-test	Post-test	Pre-test	Post-test
Score	Frequency	Frequency	Frequency	Frequency	Frequency	Frequency
5	0	18	5	16	5	8
4	0	21	4	12	4	12
3	2	6	3	14	3	12
2	17	2	2	3	2	9
1	27	0	1	2	1	4
0	1	0	0	0	0	2
Total:	47	47	47	47	47	47
Mean Percentage	**28.6%**	**83.4%**	**21.6%**	**75.7%**	**19.4%**	**62%**
Mastery Level	**Low Mastery**	**Moving Towards Mastery**	**Very Low Mastery**	**Moving Towards Mastery**	**Very Low Mastery**	**Average Mastery**

As gleaned in table 3, it shows a sudden increase of students' mastery in each Algebraic Discourse after the implementation of the intervention.

Students' mean percentage in Processual level increased up 54.8 percent having 83.4 percent on their Post-test, thus leads to mastery level of Moving Towards Mastery. Granular on the other hand, increased up to 54.1 percent having 75.7 percent on their Post-test, likewise leads to mastery level of Moving Towards Mastery. Lastly, students mean percentage in Objectified level increased up to 42.6 percent having 62 percent on the Post-test and leads to Average mastery. Thus, indicates the effectiveness of the interventions as the scores of each Algebraic Discourse increases.

Table 4: Comparison of the Pre-test and the Post-test Mean Scores
(Translating Statement into Algebraic expression)

	Post-test	Pre-test
Mean	11.12766	3.510638
Variance	4.679001	5.603145
Observations	47	47
Pearson Correlation	0.874344	
Hypothesized Mean Difference	0	
Df	46	
t Stat	45.30746	
P(T<=t) one-tail	4.07E-40	
t Critical one-tail	1.67866	
P(T<=t) two-tail	8.15E-40	
t Critical two-tail	2.012896	

The T-test: Paired two sample for means reveals a significant difference of mean scores between Pre-test and Post-test. The computed t-test value *(t stat=45.3075)* was greater than the tabular t-value *(t critical two-tail= 2.012896)* with set level of confidence 0.05 or 95 percent. Therefore, this indicates that the mastery level of the students after the given treatment was improved. Thus, the first null hypothesis was rejected with respect of translating statement into Algebraic expression.

Table 5: Comparison of the Pre-test and the Post-test Mean Scores
(Translating Algebraic expression into Statement)

	Post-test	Pre-test
Mean	4.361702	2.702128
Variance	0.80111	2.387604
Observations	47	47
Pearson Correlation	0.865528	
Hypothesized Mean Difference	0	
Df	46	
t Stat	12.76327	
P(T<=t) one-tail	5.05E-17	
t Critical one-tail	1.67866	
P(T<=t) two-tail	1.01E-16	
t Critical two-tail	2.012896	

The T-test: Paired two sample for means reveals a significant difference of mean scores between Pre-test and Post-test. The computed t-test value *(t stat=12.76327)* was greater than the tabular t-value *(t critical two-tail= 2.012896)* with set level of confidence 0.05 or 95 percent. Therefore, this indicates that the mastery level of the students after the given treatment was improved. Thus, the first null hypothesis was rejected with respect of translating Algebraic expression into Statement.

Table 6: Comparison of the mean errors in Pre-test and the Post-test Mean Scores
(Translating Statement into Algebraic expression)

	Post-test	*Pre-test*
Mean	233.5	43
Variance	1843	1110
Observations	4	4
Pearson Correlation	0.666298	
Hypothesized Mean Difference	0	
Df	3	
t Stat	**11.77475**	
P(T<=t) one-tail	0.000658	
t Critical one-tail	2.353363	
P(T<=t) two-tail	0.001317	
t Critical two-tail	**3.182446**	

The T-test: Paired for two sample for means showed a significant difference of mean errors between Pre-test and Post-test, thus makes the second null hypothesis be rejected with respect of translating Statement into Algebraic expression, due to a reason that the computed t-test value *(t stat=11.77475)* was greater than the tabular t-value *(t critical two-tail=3.182446),* significant at 0.05 alpha. Therefore, this reinforced that the mastery level of the students after the given treatment was improved, because of the significant difference between mean errors of Pre-test and Post-test.

Table 7: Comparison of the mean errors in Pre-test and the Post-test Mean Scores
(Translating Algebraic expression into Statement)

	Post-test	*Pre-test*
Mean	20	5.5
Variance	234	53.66667
Observations	4	4
Pearson Correlation	0.954824	
Hypothesized Mean Difference	0	
Df	3	
t Stat	**3.3788**	
P(T<=t) one-tail	0.021565	
t Critical one-tail	2.353363	
P(T<=t) two-tail	0.04313	
t Critical two-tail	**3.182446**	

Utilizing T-test: Paired two sample for means reveals that the computed t-test value *(t stat=3.3788)* obtained was greater than the tabular t-value *(t critical two-tail=3.182446)* with significant alpha of 0.05 or 95% level of confidence. Hence, it was significant. This means that the mastery level of the students in translating Statement into Algebraic Expression were improved based upon the students decrease of Post-test errors. Thus the second null hypothesis was rejected in terms of students' errors in Translating Algebraic expressions into Statement.

Table 8: Data Analysis of the Feedback Evaluation Sheet

FEEDBACKS	WM	Interpretation
Group Guided Discovery Approach		
1. We learn best when we are the one who construct ideas rather than listening and reading to the books.	**4.23**	**Agree**
2. It is better if we discover the underlying concepts and rules in group.	**4.13**	**Agree**
3. It enhances our higher level of thinking skills, because we actively search for the connections of each level of translations.	**4.49**	**Agree**
4. It helps us collaborate and cooperate for the collection of concepts and rules.	**4.51**	**Strongly Agree**
5. It generates interest and excitement to the classroom setting.	**4.17**	**Agree**
6. It drives our motivation and interest.	**4.27**	**Agree**
7. It practices rigorous reasoning skills.	**4.21**	**Agree**
8. It gives opportunities to share thoughts among group mates.	**4.60**	**Strongly Agree**
9. Group Guided Discovery Approach is effective for level of information retention.	**4.06**	**Agree**
10. Group Guided Discovery Approach is effective for topic that involves mastery of rules and concepts.	**4.23**	**Agree**
Average Weighted Mean:	**4.29**	**Agree**
Gamification		
1. It enhances or reinforces our learning about translating statement into Algebraic expression and vice versa.	**4.49**	**Agree**
2. It helps motivate and encourage to continue learning.	**4.57**	**Strongly Agree**
3. It improves interaction towards teachers and peers.	**4.46**	**Agree**
4. This helps achieve mastery of the rules and concepts.	**4.53**	**Strongly Agree**
5. This strategy is effective if we had learn topic.	**4.26**	**Agree**
Average Weighted Mean:	**4.462**	**Agree**

As shown in Table 8, both Group Guided Discovery Approach and Gamification were agreed by students as effective strategies in translating Statement into Algebraic Expression.

As reflected in the Group Guided Discovery section, there were only two statements got an interpretation of Strongly Agree the rest were Agree. In specific, the statements 4 and 8 got 4.5 above weighted mean and majority were ranges 4.06-4.49, thus have 4.29 total weighted mean and interpreted as Agree. This indicates that, through Group Guided Discovery approach it enhances students' learning and build a stronger connections among concepts. Hence, this creates consistency on what (Jawaharlal, 2011) reported.

Moreover in Gamification section, majority of the students agreed the effectiveness used of Games in reinforcing learning about the topic. There were 2 out of 5 statements got Strongly Agree, thus yields 4.462 total weighted mean and interpreted as Agree. This indicates that through Gamification it helps students be motivated and encouraged students to continue and reinforces learning and helps arises students' interest towards learning. Hence, this creates sameness on what (Muntean, 2011) stressed out on his study.

IV. CONCLUSIONS

After thorough analysis of the results based on the findings gathered from the study, the following were drawn:

After the implementation of the interventions which were the Group Guided Discovery approach and Gamification, the students' mean percentage score on the Pre-test with respect of translating Statement into Algebraic Expression increased by 50.66 having 75.33 percent during the administration of the Post-test. Likewise, translating Algebraic expression into statement's Pre-test increased up to 32 percent creating 86 percent during the Post-test. Thus, implies that the interventions given to the Grade 7-section Orchid were effective due to the positive result.

From among the three levels of Algebraic Discourse, students can translate the Statement into Algebraic expression easily when written in Processual style, oppositely students do have difficulty when written in Objectified. These statement was consistent on what (Sfard, 2008) referred to.

Furthermore, students' mean error in translating statement into Algebraic expression and vice versa decreased.

There is a significant difference between students' Pre-test and Post-test scores in Translating Statements into Algebraic expressions and vice versa.

There is a significant difference between students' Pre-test and Post-test scores in terms of students' errors in Translating Statements into Algebraic expressions and vice versa.

The students agreed that the used of Group Guided Discovery Approach and Gamification was effective in tanslating Alebraic expression into Statement and vice versa, because of the positive results derived from the Analysis of Feedback Evaluation sheet and reinforced qualitatively from the Interview through Focus Group Discussion.

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