Effectiveness of Lesson Exemplars on Combinatorics Using Cognitive Guided Instruction for Grade 10 Students

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Abstract: *The main purpose of this study was to determine the effectiveness of lesson exemplars on combinatorics using Cognitive Guided Instruction for Grade 10 students at Gate National High School with the topics Permutation and Combination. It developed lesson exemplars using cognitive guided instruction in teaching combinatorics. Moreover, it also included the validity of the lesson exemplars as evaluated by experts along lesson planning features and learning activities features, the mastery level of the students in the pre-test and post-test along the 2 topics and finally the effectiveness of lesson exemplars on permutation and combination using CGI. The descriptive methods of research were used in this study. The researcher used a sample size of 22 using a purposive sampling. The main instrument of this study is the lesson exemplars on combinatorics using Cognitively Guided Instruction, pre-test and post-test results and the validation sheets prepared by the researcher. Survey and test administration was used to gather the needed data. The results were tallied, tabulated and textually interpreted using appropriate statistical tools such as: weighted mean, percentage and T-test. Findings revealed that 1. Lesson exemplars on combinatorics using Cognitive Guided Instruction focuses on student learning wherein students are guided by the teacher through asking questions which leads to the correct answer. It is also a student centered and allows the students to connect their prior knowledge with the new ideas gained from the lesson exemplar on permutation and combination. The teacher will probe the answers of the students. It also lets the students discover the correct answer through the guided questions of the teacher. 2. The overall weighted mean of the lesson exemplars using CGI in permutation and combination along lesson planning features are 4.6 and 4.68, respectively, both interpreted as excellent. 3. The overall weighted mean of the lesson exemplars using CGI in permutation and combination along learning activities features are 4.51 and 4.52, respectively, both interpreted as excellent. 4. The mastery level of students in the pre-test in permutation was 22.72 interpreted as low mastery, while the mastery level of the students after the use of lesson exemplars was 25 interpreted as low mastery. The mastery level of the students in combination during pre-test was 23.18 interpreted as low mastery, in post-test the mastery level increased to 36.82 interpreted as average mastery. 5. With the degrees of freedom of 21, level of significance of 0.05 the tabulated value is equal to 2.080. In permutation, the computed value of 0.925 is lesser than the tabulated value of 2.080 which means the null hypothesis is accepted while in combination the computed value of 7.090 is greater than the tabular value of 2.080 thus the null hypothesis is rejected. The researcher concluded that a lesson exemplar using CGI in permutation and combination were made, focusing on students learning through guided questions by the teacher and letting the students discover the correct answer through the guided questions provided with the appropriate activities; the lesson exemplars on combinatorics using cognitive guided instruction were excellent in terms of lesson planning features; the lesson exemplars on combinatorics using cognitive guided instruction were excellent in terms of learning activities features; The mastery level of the students in permutation and combination improved after using lesson exemplars with CGI and that the use of lesson exemplars with CGI in combinatorics is effective. Based from the conclusions drawn after the analysis and interpretation of the data gathered from the study, the following recommendations are made. The developed lesson exemplars in this study can be adopted and improved by the teachers teaching Combinatorics for Grade 10 as these are also competency -based and focuses on students' mathematical skills. Administrators may consider conducting a seminar on the use of Cognitive guided instruction in lesson planning. Teachers may consider different activities that are suitable to the ability of the students and promote their participation. Teachers should introduce and apply novel pedagogies in the teaching and learning process to improve the performances of the students. The developed Lesson exemplars on combinatorics using Cognitive Guided Instruction be used and implemented. For future researchers, further study on the effectiveness of Lesson exemplars on Combinatorics using Cognitive Guided Instruction for diverse students', slow learners, large/small number of classes, etc.*

Keywords: Lesson Exemplars, Combinatorics, Cognitive Guided Instruction

1. Introduction

Mathematics education as a research field is to study the factors that affect the teaching and learning of mathematics and to develop programs to improve the teaching of mathematics. In order to accomplish this aim mathematics education must consider the contributions of several disciplines: psychology, pedagogy, sociology, philosophy, etc. However, the use of these contributions in mathematics education must take into account and be based upon an analysis of the nature of mathematics and mathematical concepts, and their personal and cultural development. Such epistemological analysis is essential in mathematics education, for it would be very difficult to efficiently study the teaching and learning processes of undefined and vague objects. (Godino et al., 2001). It can only be acquired through learning Mathematics.

A study carried out in Scotland which involves introducing the principles of Cognitively Guided Instruction (CGI) to 21 mainstream teachers. It considers the effect of developing CGI in classrooms focusing on teacher learning and particularly their capacity to support all learners. It demonstrates teachers' awareness of their own learning and how to increase understanding of children's' mathematical thinking left them better place to support all learners. The study highlights the importance of developing teachers' knowledge of children's mathematical thinking in order to promote inclusive practices with CGI providing a useful framework for this professional development. (Moscardini, 2014). CGI starts from the learning of students.

Education aim to grow to children into productive citizens that use their knowledge, talents, and learned skills to

sustain themselves and help others while pushing the human race forward in areas of equality, equity, and harmony (Reiss, 2007). In education there was also difficulties face by teachers specially Mathematics teachers.

The development of adequate and appropriate mathematical knowledge in secondary teachers is of paramount concern to mathematics educators globally. Teachers require strong knowledge of mathematical content to be effective in their teaching. Disconcertedly, the mathematical preparation of teachers in the United States, which is the context for this study, needs to compare more favorably with teachers in other countries as measured by prospective teachers' knowledge, beliefs, and preparation experiences (Mathematics Teaching in the 21st Century, 2007). Prospective teachers in the United States particularly need to be better prepared to adeptly teach demanding mathematics curriculum. (Hill, 2010). Effective teacher preparation programs are critically important for future teachers and the students they will be teaching. Teachers should also use proper strategy and approaches to aid the needs of students.

As students use their intuitive knowledge of mathematical concepts to solve story problems and are cognitively guided by teachers, they discover "big ideas" and key properties of math ,and learn how to think, reason, and dialogue mathematically (Carpenter, Franke, &Levi,2003). As Franke and Kazemi (2001) explained, CGI brings together research on how children's mathematical thinking develops and research on teaching to enable teachers to offer the most effective form of instruction. CGI, then, is not a prescription or recipe for instruction, but rather a "philosophy, a way of thinking about the teaching and learning of mathematics".(Munday, 2016). Children's thinking and development of their intuitive mathematical thinking and reasoning is developed through Cognitive Guided Approach therefore it should be integrated in curriculum's.

The Philippines initiated a major curriculum reform leading to the implementation of the *Enhanced Basic Education Curriculum (K to 12)* in 2013. In science education, the new curriculum "envisions the development of scientifically, technologically, and environmentally literate and productive members of society who are critical problem solvers, responsible stewards of nature, innovative and creative citizens, informed decision makers, and effective communicators" (Official Gazette of the Republic of the Philippines, n. d., p. 2). Therefore, various education stakeholders need to take initiatives in teacher professional development activities, in order for in-service teachers to acquire a full appreciation of the objectives of the curriculum reform, and learn new sets of pedagogical practices (Bernardo & Mendoza, 2009).

Youth, are the hope of tomorrow, its future, and also the hope of the church. Do we, young people, realize our responsibility and stimulus to face life's reality not merely, to fulfill our own bight dream? Do we experience how difficult the life process is in terms of growth and development. We could not choose were to be born, nor choose our parents, our family, or the environment , but we can choose the way we live; we can choose to change our lives , to be useful people not only for our families but also

for the community at large (Huijuan , 2009). There are many hard subjects in the Philippine Curriculum that needs to be modified so that students could easily understand the topics being taught by the teacher.

Combinatorics is, arguably, the most difficult subject in mathematics, which some attribute to the fact that it deals with discrete phenomena as opposed to continuous phenomena, the latter being usually more regular and well behaved. Combinatorics is also a branch of mathematics that deals with Permutation and Combination. Combinatorics is indeed a hard topic many teachers also found it hard to teach.

Permutations and combinations, while frequently included in the curriculum, are of ten tangential topics in the scope of mathematics learning and only superficially discussed. Kapur (1970)noted potential benefits for integrating combinatorics into theK-12 curriculum ,which include making conjectures, thinking systematically, one-to-one mappings, and many applications in physics, biology, and computer science. The rapid pace and content coverage required for state exams may be one source of blame for the current disintegration; however, another probable reason is alack of knowledge or comfort with combinatorics on the part of teachers. Counting problems can be very challenging, and, while expert mathematicians have succinct categories for differing problem types, the process for learning to think combinatorically may not be so neatly packaged. (Wasserman, 2013) Teachers were also startled when Combinatorics was added in the spiral curriculum in DepEd and have been added to the Learning Competencies in Mathematics that was needed to be taught to students. Since it is a hard topic needed to be discussed well to the students.

One of the most difficult topics in Mathematics was Combinatorics. Many teachers found it hard to teach the subject itself since it is incorporated with word problems therefore teachers should establish first the mathematical comprehension skill of students so that they would be able to solve problems under Combinatorics. There were two subtopics in Combinatorics namely Permutation and Combination.

As a Garde 10 mathematics teacher I also found it hard to taught my students Combinatorics since there comprehension skill is very low. When teaching combinatorics students should understand the word problems well in order to calculate it properly and arrive at the right answer. Most of my students show lack of interest when the topic is incorporated with word problems , some of them are not paying much attention to the teacher and some are just not listening that is why it's very hard me to develop to their minds the concept of combinatorics. Nearly all of my students don't show interest in solving word problems resulting to their poor performance in class.

Based from the result of the pre-test Numeracy Assessment Result at Gate National High School 5 female and 6 male with the total of 11 grade 10 students in section Bathala were identified as non-numerates which means that they were the students who were having difficulties in understanding and comprehending numerical problems

especially word problems. Many of our students nowadays are low performer in Mathematics. This triggers the researcher to conduct this research.

Statement of the Problem

This study determined the effectiveness of lesson exemplars on Combinatorics using cognitive guided instruction for grade 10 Students at Bulan, School Year 2019-2020.

Specifically, it answers the following questions.
1) What lesson exemplars using cognitive guided instruction could be developed in teaching combinatorics for grade 10 students along:
   a) Permutation
   b) Combination
2) How valid are the lesson exemplars along lesson planning features?
3) How valid are the lesson exemplars along learning activities features
4) What is the, mastery level of the students, using the lesson exemplars, in the pre-test and post-test along the 2 topics?
5) How effective are the lesson exemplars on permutation and combination using CGI?

2. Methodology

2.1 Research Design

This study determined the effectiveness of lesson exemplars on combinatorics using cognitively guided instruction for grade 10 students for S.Y. 2019-2020.

The descriptive methods of research was used in this study. Creswell (2002)stated that the descriptive methods of research is to gather information about present existing condition. The aim of descriptive research is to verify the present situation in order to elucidate it. This study used to describe the lesson exemplars using cognitive guided instruction in teaching combinatorics for grade 10 students along permutation and combination. It was also used to recognize the effectiveness of lesson exemplars on permutation and combination.

The researcher used a sample size of 22 using a purposive sampling. The main instrument of this study is the lesson exemplars on combinatorics using Cognitively Guided Instruction, pretest and post test results and the validation sheets prepared by the researcher. Survey and test administration were used to gather the needed data. The results were tallied, tabulated and textually interpreted using appropriate statistical tools such as: frequency, weighted mean, percentage and T-test.

The Sample

The researcher used the purposive sampling in determining the respondents of the study. The main goal of purposive sampling is to focus on characteristics of a population that are of interest in the study. (Ames, 2019)

This study purposively chosen the Grade 10 students of section Bathala at Gate National High School for the School Year 2019-2020.They were composed of 22 students.

For the teacher respondent who validated the developed lesson exemplar, 5 experts were also purposively chosen based from their educational background. Four of them were Master Teachers and 1 principal. They were all Mathematics majors and teaching mathematics for more than 5 years. They also have enough knowledge with Cognitive Guided Approach and were already integrating this kind of approach in their classes.

The Instrument

The main instrument used in this study is a modified lesson exemplar on combinatorics using Cognitive Guided Instruction for Grade 10 students. The researcher prepared a lesson exemplar for permutation with the integration of Cognitive Guided Approach along with a lesson exemplar for combination with also the assimilation of CGI.

One of the instruments used for the study is the evaluation sheet for the develop lesson exemplars. The following are the criteria for this instrument lesson planning features; Learning Activities Features based on LRMDS (Learning Resources Management and Development System).

The indicators under the first Category lesson planning features were based from the DepEd order No. 42,s.2016, or the Policy Guidelines on Daily Lesson Preparation for the K to 12 Program. Most of the indicators under the second category Learning Activities Features was adopted from the study of Bien (2018) and Alondra (2018).Additional five indicators were added by the researcher.

The responses from this evaluation sheet were scaled using Likert's Scale, which have the following indicators; (5)excellent,(4) very satisfactory,(3)satisfactory, (2) poor and (1) very poor.

A dry run was conducted by the researcher to validate the evaluation sheets, wherein 5 mathematics teachers checked the questionnaire and necessary corrections were made on the questionnaire based on the comments of the teachers. After finalizing the questionnaire, the Lesson exemplars was validated by 5 experts.

The researcher administered pre-test and post-test to know the mastery level of the students using the lesson exemplars. The pre-test and post-test composed of a ten-item word problem on permutation and combination adopted from the Mathematics Learner's Module of Grade 10 written by Callanta, M. et al and under the Department of Education-Instructional Materials Council Secretariat (DepEd-IMCS).

Data Gathering Procedures

The researcher prepared a letter before conducting the study. The letter solicited the approval of the School Division Superintendent and the school head to conduct the study. The researcher explained the objectives of the study and asked permission to conduct the demonstration teaching and administered the evaluation test to assess the students learning. Upon approval, the researcher conducted the demonstration teaching and distributed the test to the target student-respondents.The researcher conducted the pre-test last January 10,2020 then executed the lesson exemplar using Cognitive Guided Instruction for Grade 10 students in

permutation on January 13,2020 and ended the lesson with an evaluation. The researcher also conducted a pre-test in Combination on January 14, 2020 then demonstrated the lesson exemplar using Cognitively Guided Instruction on January 15,2020 and also ended the lesson with an evaluation to assess students learning. After the retrieval, the tallying and tabulation for statistical treatment was done. The researcher also collected journals made by the students after the demonstration.

Data Analysis Procedures
The data gathered were tabulated, analyzed and interpreted with the use of appropriate statistical measures like qualitative analysis, frequency, weighted mean, percentage and t-test. A qualitative analysis was used to determine the lesson exemplars using cognitive guided instruction that could be developed in teaching combinatorics for grade 10 students.

In determining the validity of the lesson exemplars along lesson planning features and lesson activities features, weighted mean was used. The range and corresponding description for the validation of lesson exemplars on Combinatorics along lesson planning were adopted form DepEd order No. 42,s.2016 and it is shown below.
Range Description
4.50- 5.00 Excellent
3.50-4.49 Very Satisfactory
2.50-3.49 Satisfactory
1.50-2.49 Fair
1.00-1.49 Poor

On the other hand, the range and corresponding description for the validation of lesson exemplars on combinatorics along lesson activities features were adopted from Bien (2018). The following are the range and the corresponding description:

Range	Description
4.50-5.00	**Excellent.** The lessons and activities met almost all expectations.
3.50-4.49	**Very satisfactory.** The lessons and activities met majority of the expectations. Some minor adjustments /revisions may be recommended.
2.50-3.49	**Satisfactory.** The lessons and activities met some of the expectations. Major adjustments/revisions may be recommended.
1.50-2.49	**Fair.** The lessons and activities needs major adjustments and revisions.
1.00-1.49	**Poor.** The specific descriptions or indicators of the criterion are not reflected in the lessons and activities.

To determine the mastery level of the students in the pre –test and post –test, frequency and percentage was used. The mastery level of the students was categorized using (DepEd Order No. 71 ,s.2010& "Standards-Based Assessment DEpEd's Perspective " NETRC-Department of Education):

Percentage Descriptive equivalent
96%-100% Mastered
86%-95% Closely Approaching Mastery
66%-85% Moving Towards Mastery
35%-65% Average Mastery
16%-34% Low Mastery
5%-15% Very Low Mastery
0%-4% Absolutely No Mastery
Lastly, to determine the significant difference between the mastery level of the student in the pre-test and post-test, t-test was used.

3. Results and Discussions

3.1 Findings

Based from the gathered data the following findings were revealed:
1) Lesson exemplars on combinatorics using Cognitive Guided Instruction focuses on student learning wherein students are guided by the teacher through asking questions which leads to the correct answer. It is also a student centered and allows the students to connect their prior knowledge with the new ideas gained from the lesson exemplar on permutation and combination. The teacher will probe the answers of the students. It also lets the students discover the correct answer through the guided questions of the teacher.
2) The overall weighted mean of the lesson exemplars using CGI in permutation and combination along lesson planning features are 4.6 and 4.68, respectively, both interpreted as excellent.
3) The overall weighted mean of the lesson exemplars using CGI in permutation and combination along learning activities features are 4.51 and 4.52, respectively, bothinterpreted as excellent.
4) The mastery level of students in the pre-test in permutation was 22.72 interpreted as low mastery, while the mastery level of the students after the use of lesson exemplars was 25 interpreted as low mastery. The mastery level of the students in combination during pre-test was 23.18 interpreted as low mastery, in post-test the mastery level increased to 36.82 interpreted as average mastery.
5) With the degrees of freedom of 21, level of significance of 0.05 the tabulated value is equal to 2.080. In permutation, the computed value of 0.925 is lesser than the tabulated value of 2.080 which means the null hypothesis is accepted while in combination the computed value of 7.090 is greater than the tabular value of 2.080 thus the null hypothesis is rejected.

3.2 Conclusions

The researcher concluded that:
1) Lesson exemplars using CGIin permutation and combination were made focusing on students learning through guided questions by the teacher and letting the students discover the correct answer through the guided questions provided with the appropriate activities.
2) The lesson exemplars on combinatorics using cognitive guided instruction were excellent in terms of lesson planning features.
3) The lessons and activities in the lesson exemplars on combinatorics using cognitive guided instruction met almost all expectations based on the evaluation of the experts.
4) The mastery level of the students along combination improved after using the lesson exemplar with CGI.On

the contrary, there is no significant increase on the mastery level of the students along permutation.

5) The use of lesson exemplars with CGI in permutations was not effective while the use of lesson exemplars with CGI in combination is effective.

4. Recommendations

Based from the conclusions drawn after the analysis and interpretation of the data gathered from the study, the following recommendations are made.

1) The developed lesson exemplars in this study can be improved and adoptedby the teachers teaching Combinatorics for Grade 10 as these are also competency-based and focuses on students'mathematical skills.

2) Administrators may consider conducting a seminar on the use of Cognitive guided instruction in lesson planning.

3) Teachers may consider different activities that are suitable to the ability of the students and promote their participation.

4) Teachers should introduce and apply novel pedagogies in the teaching and learning process to improve the performances of the students.

5) The developed Lesson exemplars on combinatorics using Cognitive Guided Instruction be used and implemented.

6) For future researchers, further study on the effectiveness of Lesson exemplars on Combinatorics using Cognitive Guided Instruction for diverse students', slow learners,large/small number of classes, etc.

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