ALTERNATIVE GENERAL FORMULA IN FINDING THE EXCESS AREA OF A REGULAR POLYGON INSCRIBED IN A CIRCLE

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Abstract

The study used a Pretest-Posttest Quasi Experimental Design to determine the effectiveness of the alternative general formula in finding the excess area of a regular polygon for the Grade-12 Senior High School STEM students of Tigao National High School which tapped 40 students as subjects of the study. The result showed that the subjects' mean scores increased greatly from the pretest to the posttest. The results indicated that using the alternative general formula increases students' achievement. As a result, using the alternative method was more beneficial and effective for students because it was easier for them to find the excess area of a regular polygon inscribed in a circle compared to using the original formula. The calculated P-value in pre-test is 0.102, which is greater than the alpha level of 0.05. It failed to reject the null hypothesis which means that there is no significant difference in the pretest mean scores. The computed P-value in posttest 0.000 is less than the 5% alpha level. It rejects the null hypothesis which implies that there is a highly significant difference between the original formula and the alternative general formula. The computed P-value of 0.615 in the interaction effect between the Formula Used and Mathematical ability is greater than the 5% alpha level. As a result, it may be inferred that the Formula used and the mental capacity have no meaningful interaction. The alternate formula, regardless of the students' mental capacity, provides a more efficient and helpful method for both groups, whether they belonged to the average or advanced group.

Keywords: Alternative General Formula, Excess Area, Regular Polygon, Circle

1. Introduction

Finding an area is one of the most important topics presented in geometry. Because determining the area of a regular polygon necessitates a thorough mastery of trigonometry, this study focused on the six basic trigonometric functions. In the academic experience of the students, they will eventually run into problems calculating the excess area of a regular polygon inscribed in a circle given either a side of the regular polygon or the radius of the circle. This study presented a convenient method for calculating the excess area of a regular polygon inscribed in a circle given either a side of the regular polygon or the radius of the circle. The

7006

purpose of this study is to see how well the alternative formula approximated the extra area of a regular polygon inscribed in a circle given either the regular polygon's side or the circle's radius.

According to Peteros et al. (2019), students faced numerous problems in mathematics. Capuno et al. (2019), in the 2016-2017 Global Competitiveness Report, shows that Filipino learners' arithmetic ability has to be improved. To give appropriate intervention, many criteria were investigated. One of the most common explanations is that learners are cognitively confused and find it difficult to concentrate on many calculations and mathematical procedures. Dealing with too many variables or bits of information at once can sabotage student learning and result in huge achievement discrepancies. This was much easier because, unlike the traditional method of calculating the excess area of a cyclic polygon, which involved calculating the area of both the circle and the polygon and then subtracting the area of the latter from the area of the former, simply assigning the value of a given side or radius to the respective alternative will simplify the solving process for them. Hence, when given a hundred-plus-sided regular polygon, getting the answer will not be a problem for the students provided that this alternative formula will ease the solving process since the students only need to put the given value into the formula. This research could contribute to a fun learning experience with problem solving involving mathematics.

These kinds of formula can help learners solve real-world problems more quickly, train them to think conceptually, and train them to be skeptical of what they have already learned. The result of this study will play a significant role in the field of mathematics education, particularly in providing more viable solutions to simple and more complex math problems. With this alternative general formula, students will be relieved of the burden of calculating the areas of the circle and the regular polygon, then subtracting the polygon's area from the circle's area. The advantage of using the alternative formula is that a student only needs to substitute the given required values without performing any additional calculations. This will allow them to spend less time figuring out how to calculate the excess area of a regular polygon encircled by a circle. As a result, a more convenient option is provided.

2. Theoretical and Conceptual Framework

The amount of work and time it took a student to solve a problem involving finding the surplus area of a regular polygon etched in a circle was significantly reduced. Piaget (1985, cited by Zhao et al. (2011) believed that a child's difficulty understanding a notion resulted from the issue's rapid progression from a subjective structure to a mathematical representation. Observation has shown that in math classes where traditional instructional strategies have been the dominant method of teaching, students may not be able to internalize the massive amount of knowledge or content presented by the teacher, making it nearly impossible to fully develop their understanding.

According to his theory of academic advancement, intelligence is a developing phenomenon that occurs in predictable stages with a consistent order. This study is anchored on Bruner (1986), as cited by Zhao et al. (2011), that learning is a dynamic process in which students generate new thoughts or ideas based on prior knowledge. It's about shaping our perception of what can be considered customary or ordinary and then creating something to improve on that routineness. It is related to this study in the sense that the researcher selects and changes data, generates hypotheses, and makes decisions based on a mental framework.

Bruner's theoretical framework included a significant theme that learners generate new

ideas or concepts based on their current or past knowledge during the learning process. The learner selects and transforms information, develops hypotheses, and makes decisions, all while relying on a cognitive structure. The cognitive structure gives meaning and organization to experiences and enables an individual to "go beyond the information provided."

These ideas and concepts are related in the researchers' study as well as in Bruner's theory of Domain and Structural Information, clarifying that a specific student should not rely on the given formulas; instead, he/she is encouraged to create his/her own formula based on previous learning, in this case, on finding the excess area of a regular polygon inscribed in a circle. Because the mind is designed to explore possibilities and learning is a continuous process of pursuing them, figuring out how to use what we already know to go beyond what is currently thought is manifested and exhibited. The central concept of this study is fixated on the effectiveness of the alternative general formula in finding the excess area of a regular polygon inscribed in a circle.

3. Statement of the Problem

The study's purpose is to assess the effectiveness and efficacy of the alternative general formula in finding the excess area of the regular cyclic polygon. It intends to determine the pretest and posttest mean score of the research subjects when applied with the original and alternative general formulas and finding out if there is significant difference and interaction effect between the scores of the students using original and alternative formulas.

4. Research Design and Methods

This study used a one-group pretest-posttest Quasi experimental design. This design has a comparison between the results of the pretest and posttest of the two groups using the original and alternative formulas in finding the excess area of a regular cyclic polygon.

The researchers used a Pretest-Posttest Quasi Experimental Design to determine the effectiveness of the alternative general formula in finding the excess area of a regular polygon for the Grade-12 Senior High School STEM students of Tigao National High School for the subject of the study. The researcher then analyzed and interpreted the results of the pretest and posttest given to the students before and after the instructional process regarding the effectiveness of the alternative formula. This study was conducted at Tigao National High School during the semester of School Year 2021–2022. It is situated at Barangay Tigao, Cortes, Surigao del Sur. The researchers chose Tigao National High School to be the school where this study was conducted as the school is known to be one of the top-performing secondary schools in the Municipality of Cortes. Aside from this, among the national schools in the municipality, only Tigao National High School offers a STEM strand in which the students of the said strand are of great interest to the researchers to be this study's research subjects.

In selecting the subjects of this study, the researchers used the intact group (1 section) and divided the class into. Random sampling was used to identify who are the students to be included in Section A, to use the Original formula and Section B, to use the Alternative formula. There is only one section of STEM students in this institution, and so the researchers selected twenty (20) to use the Original formula and another twenty (20) Students to use the Alternative formula. The researcher sees to it that students have the same mental ability. Thus, there were forty (40) students that were chosen as this study's research subjects.

This research used a validated and reliability-tested researchers-made problem-solving

7008

test questionnaire to assess the performance of the subjects, finding the excess area of a regular polygon inscribed in a circle using the alternative general formula. The said test questionnaire was submitted to and validated by the three experts in mathematics. They examined the content thoroughly with the use of the provided rubrics. The experts gave their comments to correct and revise the questionnaire. The enhanced portion was the format of the test questionnaire only.

After the experts validated the instrument, it was then tested for reliability. The researchers used the Split-half method with the use of the Spearman-Brown Formula. Twelve (12) Geodetic Engineering students from Caraga State University, three (3) third-year, and one (1) fourth-year BSEd Mathematics students from the College of Teacher Education of Surigao del Sur State University were used as the subjects for this test. The result was 0.98, which indicates that there is a very high correlation between the instrument being used by the researchers. Therefore, the researchers-made test questionnaire is reliable and valid. After the necessary permission from the SDSSU – Main Campus and Tigao National High School administrations had been pursued and granted, the researchers proceeded with the conduct of the study.

5. Results and Discussion

First, the researchers gave a pretest to the two groups of subjects, followed by a discussion. It was then followed by a posttest wherein the researchers made the Group B use the alternative general formula and the original formula for the Group A.

After the given tests, the results were gathered and calculated to determine whether the alternative formula is more effective and convenient in finding the excess area of a regular polygon inscribed in a circle compared to the original formula. This research used the following statistical tools: Mean, Paired T-Test, and Two-way ANOVA.

Table 1- Pretest and Posttest Mean Scores of the Two (2) Formulas

Variables Tested	Mean		Mean Gain Score
	Pretest	**Posttest**	
Original Formula (Group A)	6.1	6.55	1.25
Alternative Formula (Group B)	6.3	9.15	2.85

Table 1 shows the students' major gain scores, as well as their mean pretest and posttest scores. For the pretest result, there is only a slight difference on the decimal points – 6.1 in Group A which is the Original Formula group and 6.3 in Group a which is the Alternative Formula group. Because it only examines the students' previous knowledge, it does not imply that the alternative formula made some significant difference among their scores.

On the other hand, the achievement of the mean scores from the pretest to the posttest of Group B who used the alternative formula which is 9.15 is greater than the increase of the mean of Group A which is 6.55. This only means that using the alternative general formula helped the subjects improve their test scores for finding the excess area of a regular polygon inscribed in a circle.

In the process of solving an exact equation (e.g., a differential equation) using the usual approach, according to Portillo et al. (2017) in their study on the exposition to solve an exact differential equation, they discovered this while obtaining the general solution to the exact equation. They pointed out that they could reshape the traditional method into a derived method by obtaining information on the solution process.

The conventional method assisted students in calculating the general solution, but it took

7009

more time and was a longer process, whereas the derived method yielded a similar general solution as the conventional method in a shorter time and process. They concluded that the general solution of a derived method was the same as the traditional method, but the derived method was preferable.

Table 2- Significant Difference on the Pretest and Posttest Scores

Summary of Variation	Computed Value	P-Value	Decision Rule	Conclusion
Pretest	2.000	0.102	Failed to Reject H_0	Not Significant
Posttest	7.409	0.000	Reject H_0	Highly Significant

It can be seen in Table 2 that the computed P-value in pretest is 0.102, which is greater than the alpha of 0.05. This failed to reject the null hypothesis, thus implying that there is no significant difference in the pretest mean scores. It can be inferred that learners have equal mental capability. However, the p-value of 0.000 in the pretest and posttest mean scores is less than the 0.05 level of significance. This rejected the null hypothesis which means that there is a significant difference in the posttest mean scores.

As a result, the alternative formula improved their scores better compared to the original formula when it came to calculating the excess area of a regular polygon inscribed in a circle.

This result is related to the study by Ignacio et al. (2017), which found that using the alternative formula is preferable to using the conventional method. The researcher concluded that using an alternative procedure in finding solutions (for example, determining the number of diagonals in a closed polygon) is preferable to the original or traditional method of solving. Finding solutions using the original method or solving would yield an exact answer, but it would take far too long. Unlike the derived or alternative formula, the solution would yield an exact answer in a short amount of time and in a simple manner by simply substituting the given values. As a result, both methods yielded the same exact answer, but the alternative method was more efficient than the original method.

It can be gleaned on Table 3 that at 0.05 significance level, it showed that for Factor A which is the Formula Used has a P-value of 0.000 which is lesser than 0.05, rejecting the null hypothesis. However, Factor B has P-value of 0.234 which is greater than the significance level of 0.05, thus the result failed to reject the null hypothesis implying the students are of the same mental ability.

Table 3- Significant Interaction

Sources of Variation	Computed Value	P-Value	Decision	Conclusion
Factor A (Formula Used)	14.52	0.000	Reject Null Hypothesis	Highly Significant
Factor B (Mathematical Ability)	2.38	0.234	Failed to reject null hypothesis	Not Significant
Factor A*Factor B	0.50	0.615	Failed to Reject Null Hypothesis	Not Significant (No Interaction Effect)

Moreover, it reveals that there is no interaction effect between the Formula Used and Mathematical ability of the students with corresponding p-value of 0.615 which is greater than the significance level which is 0.05, thus we failed to reject the null hypothesis.

Therefore, it can be concluded that there is no significant interaction with the Formula

7010

Used and mental capacity. It can then be inferred that regardless of the mental capacity of the students, the alternative formula offers a more efficient and beneficial way for both groups whether they belonged to the average or the advanced group.

This result is related to the study by Laurezo and Magallanes (2020), which found that mental ability played a role in determining every student's abilities and potential in the learning process particularly in Mathematics. Moreover, the researchers concluded that there is a significant relationship between students' mental ability and their academic performance in Mathematics. Furthermore, the mathematical ability and academic performance are correlated. Thus, the findings revealed that mental ability could predict the academic performance of the students.

6. **Conclusions and Recommendations**

The result showed that the subjects' mean scores increased greatly from the pretest to the posttest. The pretest for the Group A is 6.1 and for the Group B is 6.3 while the mean score of the Group A in the posttest is only 6.55 compared to the mean score of the Group B which is 9.15. It only showed that there was an increase in students' achievement after conducting the original formula and the alternative general formula. However, it was evident that the Group B who used the alternative general formula had a higher mean score than the Group A who used the original formula. The results indicated that using the alternative general formula increases students' achievement. As a result, using the alternative method was more beneficial and effective for students because it was easier for them to find the excess area of a regular polygon inscribed in a circle compared to using the original formula.

The calculated P-value in pre-test is 0.102, which is greater than the alpha level of 0.05. It failed to reject the null hypothesis which means that there is no significant difference in the pretest mean scores. The computed P-value in posttest 0.000 is less than the 5% alpha level. It rejects the null hypothesis which implies that there is a highly significant difference between the original formula and the alternative general formula.

The computed P-value of 0.615 in the interaction effect between the Formula Used and Mathematical ability is greater than the 5% alpha level. It failed to reject the null hypothesis, implying that there is no significant interaction effect between the Mathematical ability of the students and the formula they used. As a result, it may be inferred that the Formula Used and mental capacity have no meaningful interaction. The alternate formula, regardless of the students' mental capacity, provides a more efficient and helpful method for both groups, whether they belonged to the average or advanced group.

Teachers are encouraged to use the alternative formula since, in solving problems, it is more effective, efficient, and less complicated. Teachers and students are encouraged to be innovators and discoverers by developing new concepts or methods for solving such mathematical problems to have a richer learning experience that is both relevant and accessible. Using an alternative formula would increase students' interest in learning mathematics.

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7011

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7012

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